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THE BERLIN POWER-HOUSE AND THE ELEVATED ROAD PASSING DIRECTLY THROUGH IT.

THE BERLIN ELECTRIC UNDERGROUND AND ELEVATED RAILWAY.

THE UNDERGROUND AND ELEVATED ELECTRIC RAILWAY IN BERLIN—NOW COMPLETED AND IN OPERATION.*

By FRANK C. PERKINS.

As far back as 1880 the Berlin authorities were submitted a proposition for an elevated electric railway of the narrow-gage type, but the plan was dropped on account of the opposition from many of the citizens of Friedrichstrasse, through which the road was to run.

It was intended to go from Wedding in the north to Bellealliance Place in the south, and there were to be two tracks on Friedrichstrasse supported on columns and steel framework. On account of the narrow street this scheme was abandoned.

Other plans and routes were proposed from time to time, and finally the present line of underground and elevated electric railways was decided upon. It extends through the central portion of the city from east to west, beginning at the Zoological Garden and passing around Kaiser Wilhelm Gedächtniss-Kirche as an underground road, continues underneath the streets Tauenzien and Kleist Strasse to Nollendorf-Platz, where the line rises to the surface.

From this point it continues on an elevated structure through Oberbaumstrasse, Skalitzecstrasse, Kott-

BRIDGE AND STATION AT STRAULAUER THOR.

THE STATION AT SCHLESSISCHES THOR.

THE ELEVATED ROAD PASSING THROUGH A BUILDING BETWEEN TREBBINERSTRASSE AND LÜCKENWALDERSTRASSE.

THE BÜLOWSTRASSE VIADUCT.

THE BERLIN ELECTRIC UNDERGROUND AND ELEVATED RAILWAY.

buser Thor, Wasser Thor and along Gitschiner Strasse, Hallesches Thor and the Hallesches Ufer.

It then crosses the Oberbaum Brücke over the Spree River and through Straulauer Thor and Warschauer Platz to Warschauer Br. There is a most interesting triangular switchback where the main line joins with the branch connecting with Potsdamer-Platz.

The Berlin railways are operated by the Gesellschaft für Elektrische Hoch- und Untergrundbahnen, and at present consist of something less than ten miles of underground and elevated lines.

A large portion of this system is now in operation and the proposed extensions are under headway. It may be of interest to consider what has already been done and note the plans of the power house and its equipment.

The power house is located near the center of the line and at a point where the greatest consumption of energy takes place. This is near the triangular junction illustrated, where the line meets the Ringbahn at the Potsdam station.

A continuous current is generated in the Central Power Station at a pressure of 750 volts, and is conducted from there directly to the special contact rails and feeder conductors along the tracks of the elevated and underground construction. The return current passes through the track rails, which are copper bonded at the joints and also joined across the tracks.

The power station at Trebbinerstrasse is several stories high, on account of the increased cost of land in this location. The boiler equipment consists of Gehre boilers with a heating surface of great area, and they operate at a pressure of 10 atmospheres and a superheat of 200 deg. Cent. The boilers are located on the top floor of the building, and a system of Hunt conveying apparatus is used for carrying the coal to the large bunkers above.

The six boilers of the watertube type which have been installed for the present requirements have a total heating surface of about 15,000 square feet, and two steam pumps have been supplied which have a capacity of 21,000 gallons of feed water per hour. The superheated steam at a pressure of from 135 to 150 pounds supplies the 900 horse power vertical engines located on the floor below.

The feed water is pumped from the Landwehr canal or from a tank into which the air pump discharges. The exhaust from the pumps is led in to this tank, and also the condensation water from the steam pipes. A Siemens meter is used to measure the feed water, and the feed pipes and steam pipes for these pumps are duplicated so as to provide against accidents which might occur.

The steam distribution consists of a main ring pipe over the double series of boilers, and the branches are carried between the boilers to the engine, shaped pieces and cast-iron bends being employed, the flanges being rolled on. The flanges are protected by removable caps, and the whole system of piping is thoroughly insulated.

The boilers are provided with superheaters, which greatly increase the efficiency of a large power plant, and it is possible to raise the temperature of the steam to 440 deg. Fahr. The superheater is arranged so that the tubes are very near the fire and are placed where in some boilers the fifth bottom series of tubes are located. If it is so desired, the superheaters may be used to generate steam by the manipulation of some of the valves and filling the heaters with water, as the superheater tubes are in the combustion chamber among the water tubes.

The condensers as well as the air and feed pumps are placed in the basement in the space left open around the engine foundations. The air pump is operated by a small crank on the extended engine shaft. There are two tanks in the basement of the engine house connected with the canal, and the water is on the canal level in the tanks, and connected with the condensers by a pipe of large diameter. Each condenser has separately arranged injector pipes taking water from the tanks, while the waste water is carried by a pipe 0.8 of a meter in diameter under the entrance in the yard back of the canal after first passing a filtering well.

The boiler equipment, as usual with large modern power plants, occupies a much larger space than the engine plant, and hence the whole of the first floor was not required for the engines, even allowing for the necessary extensions. This floor is therefore divided by columns and provided with an intermediate floor for a repair shop, the lower portion being used for the switchboards and electrical apparatus.

The main engine room is divided into two parts by columns, and there is on the side facing the street a 15-ton crane, while on the other side there is a 20-ton traveling crane.

These heavy cranes are electrically operated by direct-current motors, and were used in the erection of the engines and generators and will be utilized for any changes or repairs which may become necessary.

The engine equipment consists for the present of three direct-connected units of a normal capacity of nearly a thousand horse power, and having a maximum capacity of much more. The engines are of the vertical compound type, each directly coupled to a German shunt-wound dynamo.

These compound condensing engines operate at a speed of 115 revolutions per minute. The high-pressure cylinder has a diameter of 31½ inches and the low-pressure cylinder measures 50 inches in diameter, while the length of the stroke is 29½ inches.

The valve gear used on the high-pressure cylinders is of the Colmann type, while for the low-pressure cylinders the ordinary piston slide valves are employed. There are two platforms provided on each of these engines for adjusting, lubricating and caring for the crosshead guides, stuffing boxes, valve gear and oiling devices. These platforms are all connected together by iron bridges, so that the attendants may pass from one engine to the other without descending to the floor.

An extension of the engine crank shaft is provided for operating the governor. The flywheels are started by a 20-horse power electric motor-driven mechanism with barring gear, which is automatically cut out when the engine has attained sufficient speed. The flywheels weigh about 32 tons each, and the arms are inclosed with sheet metal, preventing in this way the throw-

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

ing of oil as well as the creation of excessive draughts about the machinery.

The electrical generators are of the shunt-wound direct-current inner-pole type with ring armatures. The constructors designed special dynamos for this plant, the combined armature and commutator type, with the commutator on the periphery of the armature, not being considered adapted to the plant. A very large separate commutator is used, which does not form the actual surface or circumference of the armature winding.

(To be continued.)

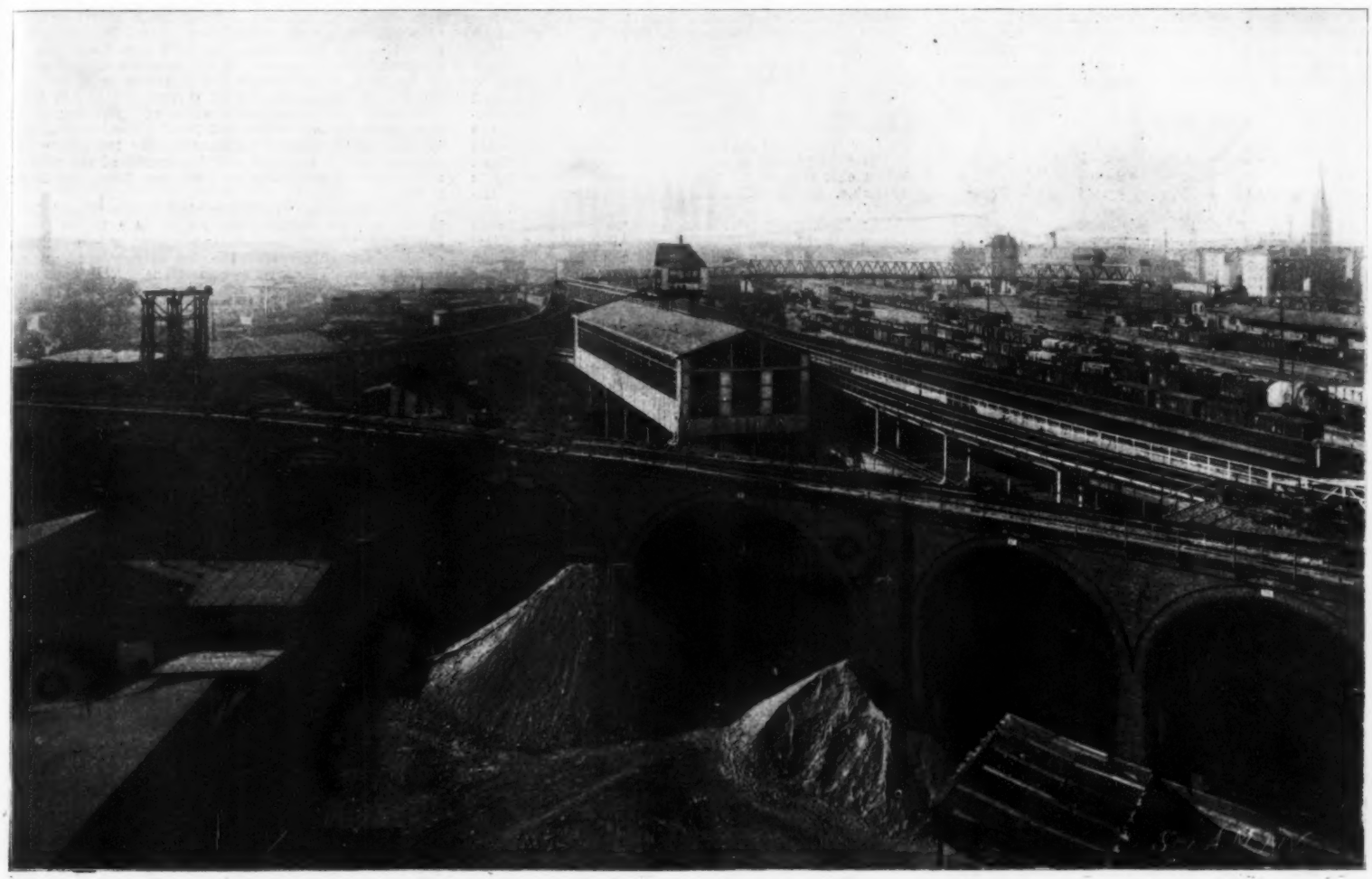
COMMERCE IN THE SOUDAN.

THE British vice-consul at Tripoli has made an interesting report to the British Foreign Office regarding the present deplorable commercial position and retrogression of the Soudan and the practical cessation of caravan transport. Not only have exports and imports decreased, the former by 22 per cent and the latter by 27 per cent, but the two combined have not stood at so low a figure for at least ten years. The country has little to give, the purchasing power of the people has been reduced, and trade with the interior of Africa is continually diminishing so that foreign goods can no longer be imported to the same extent as formerly, and the feeling of uncertainty which prevails among merchants and all classes as to the commercial future of the country in no way tends to improve the situation. The impetus which had lately been given to trade with Wadai and which had induced some of the native merchants to dispatch important caravans there, was only of short duration, for internal troubles of a serious nature in that country soon afterward compelled all but the most reckless to break off business relations with it. Traders, however, tempted by high prices said to be ruling in Kano, have left Ghat with small quantities of goods for Air and Kano, but the caravan trade with western Soudan is now at a standstill, and large purchases of European manufactures for export to Kano are no longer taking place, people not having acquired sufficient confidence since the capture of their large caravan homeward bound in autumn last to engage in trade with those countries. The quantity of goods dispatched to the interior within the last few months has been quite insignificant. All exports with the exception of cattle have decreased or remained stationary, the falling off being most marked in articles from the interior such as Soudan skins, ostrich feathers and ivory, which have been brought to Tripoli in comparatively greatly reduced quantities.

A NEW EGYPTIAN RAILWAY.

THE convention signed between the Egyptian government and the Suez Canal Company, for the prolongation of the existing railway from Cairo to Ismailia to Port Said, along the bank of the Suez Canal, on the land of the canal company, is an important agreement, which seems to be as advantageous for the Egyptian administration as for the canal company. The plant and materials required for the construction of the line are to be admitted into Egypt free of customs duty. The works are to commence immediately after the exchange of the definitive ratifications—that is to say, at the end of April or May. It is the existing tramway line which will be utilized for the railway. The transformation of that tramway line into a railway of the ordinary gage will, it is calculated, cost about 10,000,000 francs, and be completed by the autumn of 1903. The railway built at the expense of the canal company on its land will remain the property of that company till the expiration of its concession in 1968, when it will revert to the Egyptian government, with the Suez Canal itself. In the meantime, the railway is to be let by the company to the Egyptian government, which will work it in connection with its line from Cairo to Ismailia, so that there will exist direct railway communication between the Egyptian capital and Port Said.

As the tramway which was necessary for the service of the canal will be suppressed, the Egyptian administration undertakes to carry the company's servants, etc., over its line from Port Said to Ismailia free of charge, and to pay an interest of 3 or 3½ per cent per annum not only on the cost of transformation of the tramway line into a railway, but also, as is just, on the original cost of the construction of the tramway, amounting to about 7,000,000 francs. In connection with this improvement, a free port is to be created at Port Said on the land and under the administration of the Suez Canal Company, which will construct the necessary docks, wharves, quays, etc. It will naturally be completed by a custom house for goods entering or leaving Egyptian territory. The last general meeting of the Suez Canal Company adopted a resolution for the issue of a loan of 25,000,000 francs, which will, however, only be issued in installments as occasion may require.



THE TRIANGULAR SWITCHING JUNCTION ARRANGED TO OBVIATE THE CROSSING OF TWO TRACKS AT THE SAME LEVEL.

THE BERLIN ELECTRIC UNDERGROUND AND ELEVATED RAILWAY.

THE RUTHENBERG ELECTRIC IRON PROCESS.

ONE of the interesting papers read before the American Electro-Chemical Society at its second annual gathering at Niagara Falls last week was on the subject of "Developments in Electrometallurgy of Iron and Steel." The author of the paper was Marcus Ruthenberg, of Philadelphia, in whose absence the paper was read to the convention by Dr. Edward Hart, of Easton, Pa.

Mr. Ruthenberg refers to the magnetic concentration of low grade magnetites and the efforts to briquette the concentrates in order to prepare them for the blast furnace, and then describes his own method:

"In strong contrast to the above enumerated methods of handling these fine ores or concentrates is the method that I have had in use for upward of a year. It consists in taking the concentrates cleaned up to the highest point of possible purity, and putting them through an electric furnace, the melting zone of which is a magnetic field. The ore being magnetic, the magnetic field grabs and holds the grains of magnetite, and the polar projection of this magnetic field being at the same time the electrodes of the smelting circuit, the magnetic bridge thus formed by the ore forms a high resistance in the smelting circuit. The heat of the smelting circuit, therefore, is engendered within this bridge of ore itself. The electrodes are water cooled and play no part in the melting other than to conduct the current to the ore. The moment that the ore melts it loses its magnetism, and gathering weight from new molten material being added to it, it falls out of the magnetic field, its place being taken by fresh portions of ore from above. The result of this operation is agglomerated, coherent masses, ranging in size from a bean to a walnut, that are hard, strong, tough and porous, differing in analysis in no way from the ore prior to its agglomeration except for the absence of moisture and the last traces of sulphur. The product is in an ideal condition for use in the blast furnace.

"If a reducing material, such as powdered coke dust or charcoal dust, be added to the charge prior to its introduction to the electric furnace, a partial reduction takes place and the fritted mass of carbonaceous dust and iron ore, partially reduced, is dropped into a soaking pit. If allowed to remain in this soaking pit a proper length of time cementation takes place through the action of the heat left in the ore by the electric furnace, and the action of the carbon fritted into the mass, which results in producing reduced metal, which may be properly termed steel. Any slag forming material remaining in the ore through imperfect magnetic concentration remains with the metal. These materials in any event are comparatively small in quantity, and are just what is wanted to protect the bath of molten metal in the open hearth from the scorifying effect of the furnace. This material from the soaking pits is ideal for melting in the open hearth furnace. It thus becomes possible to produce first-class steel direct from the ore through the intermediary of the electric furnace and the soaking pits in the form of spongy iron or steel ready for immediate melting in the open hearth without the intervention of the blast furnace in any part. The blast furnace, while well recognized as an economical machine, is essentially a concentrator, eliminating the gangue of the ore, the limestone and the ash of the coke as a cinder or slag. It costs far less to grind and magnetically concentrate for the removal of the gangue. The blast furnace also has the disadvantage of driving whatever phosphorus there may be in the ore into the resultant pig iron. The removal from the ore of this metal by magnetic concentration is a decided advantage over the blast furnace. It may be as well also to remember the fact that the limestone and fuel charge are never entirely free from sulphur and phosphorus, which in the action of the furnace are driven into the resultant pig iron, the phosphorus entirely and the sulphur partially. In the electric reduction limestone is practically absent, fuel in contact with the charge is lacking, and reducing material necessary for the elimination of the oxygen of the ore is small in quantity and may therefore be selected of exceptional purity without regard to its enhanced cost. Anything that will burn may be used for fuel to generate the electric current, which is the source of heat to be utilized in the reducing and melting of your ore. If water powers of magnitude be available they are sources of energy convertible into heat units not to be ignored.

"In connection with this subject it may not be amiss to speak of one class of ore which has attracted attention for many years, but no advantageous method has been put forward of handling it. I refer to ferruginous beach sands. These occur in many parts of the

world, the most notable being those of the St. Lawrence River and the Pacific Coast of the United States. They also occur of greater or less richness in the West India Islands and Australia. An almost universal accompaniment of the magnetite in these beaches is titanium. The titanium generally occurs in separate grains of ilmenite. The ilmenite is less magnetic than the magnetite, and by gauging the strength of the magnets they may be made to take magnetite and leave the ilmenite. These beach sands may readily be concentrated up to 71 per cent of magnetic iron out of the possible 72.40 per cent. The sulphur and phosphorus are almost invariably low, and these sands make one of the most inviting fields for this kind of work.

"Theoretically it has been stated by various authorities that it takes from 3,000 to 3,500 K. W. H. to melt a ton of iron ore electrically. In my experience I have succeeded in performing this fritting operation, either with or without reducing agents, with an expenditure of something less than 500 K. W. H. Every ore, of course, is a distinct proposition in itself, but there are few ores that will not stand the cost of this method of treatment."

ELECTRICITY IN GLASS MANUFACTURE.

IT is significant of the progress now being made in the application of electrical power to industrial purposes, that experimental trials are taking place in Germany with a new form of glass furnace, in which electricity replaces gaseous fuel as the source of heat. The modern form of regenerative gas furnace used in glass making is such an efficient heat economizer, that the electric furnace cannot compete with it where coal is cheap. But for some varieties of glass manufacture the regenerative gas furnace is not applicable, and in many countries and localities of Europe fuel is too costly for glass manufacture to be a profitable industry. In these countries and localities cheap electrical power derived from falling water is generally available, and it

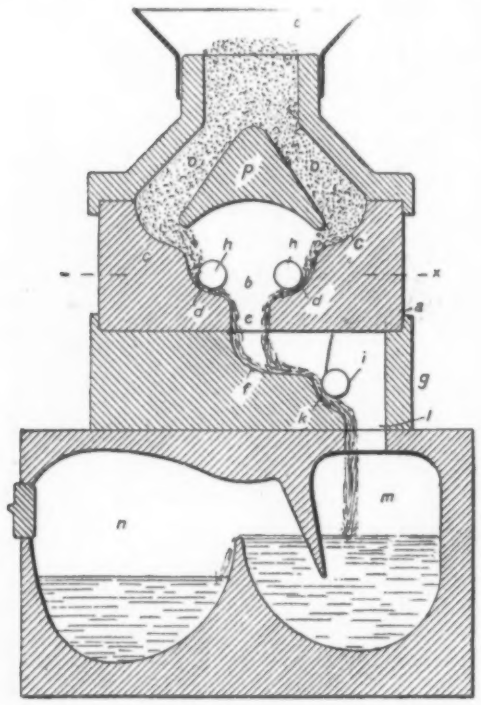


Fig. 1—THE BECKER ELECTRIC FURNACE

is possible that the present trials with electrically heated glass furnaces at Cologne, may lead to industrial developments at one or other of the water-power centers in Europe and America.

The subject is therefore of interest in connection with the future of one of the oldest British industries, for it is within the range of possibility that as fuel becomes dearer, a gradual transfer of the glass manufacture from Lancashire and Yorkshire to Switzerland and Norway may be witnessed.

In a recent issue of the Elektrochemische Zeitschrift, Dr. Bermbach has discussed the theoretical and practical aspects of the problem, and has given details of the Becker furnace used in the experiments at Cologne. The facts and figures given below are drawn chiefly from this article. The old form of glass furnace, in which the raw materials of the manufacture were charged into large crucibles, or "pots," heated by direct firing, are stated by Muspratt to have possessed a thermal efficiency of 18 per cent. The heating requisite to produce a "melt" with these pots lasted eight to ten hours, and fourteen to sixteen hours additional heating was required to obtain a glass fit for blowing or rolling. The consumption of coal in this type of furnace varies from 3 pounds to 4 pounds per pound of glass produced, and even when the pots are gas-fired the fuel consumption is still much higher than with the regenerative furnaces. Taking the raw material of glass manufactures as Na_2Co_3, $CaCo_3$, and SiO_2, thermal calculations will show that 746 calories of heat are required to melt 1 kilogramme of glass, and 250 calories additional to clear this glass from gas bubbles. Good coal, however, should yield 7,500 calories per kilogramme on complete combustion, and the actual efficiency of the ordinary type of "pot" furnace in glass manufacture, is thus seen to be even lower than stated by Muspratt, for theoretically 1-7 pound of coal should produce 1 pound of glass.

If gas-firing be applied to "pot" furnaces—a combination now used in up-to-date glass works, where "tank" furnaces are not permissible—the fuel consumption can be reduced to 1.5 pounds per pound of finished glass, and when regenerative tank furnaces are employed the fuel consumption can be further reduced to 0.50 pound. These furnaces are estimated to yield 42 per cent of the thermal value of the fuel in the furnace itself. The difference between the 3,150 calories carried into the furnace, and the 1,000 calories necessary to produce 1 kilogramme of clear glass, free from CO_2 bubbles, must be ascribed to radiation and other losses from the furnace walls and working holes.

Passing next to a consideration of the theoretical aspects of electrical working, the experiences with carbide furnaces have proved that 75 per cent to 80 per cent of the theoretical energy of the arc can be utilized in the furnace.

One may therefore calculate that to produce 1 kilo-

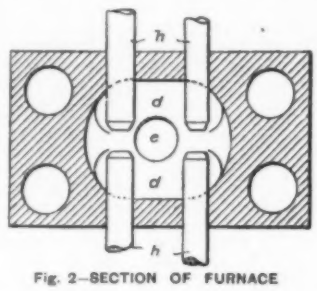


Fig. 2—SECTION OF FURNACE

gramme of melted glass free from CO_2, 1,160-watt hours would be required. As the temperature of the electric arc is about 3,500 deg. Cent., some alkali would be volatilized in the melting operation, and a 10 per cent loss of heat must be allowed for; this raises the watt-hours required to produce 1 kilogramme of glass to 1,320. Even when the electrical energy is produced from coal, the electric furnace may be expected to compare favorably with the hand-fired pot-furnace, as the fuel for generating the electrical energy required should not amount to more than 1½ pounds per pound of glass. When cheap electrical power generated from water is available, the position is, of course, immensely improved.

The Becker electric furnace experimented with at Cologne is shown in Figs. 1 and 2. Fig. 1 is a vertical section of the furnace, and Fig. 2 a horizontal section of that portion of the furnace where the arc heating occurs, marked *H H* in Fig. 1. The raw materials of the glass manufacture, sand, lime, and sodium carbonate, are well crushed and mixed, and fed into the hopper, *t*. From this they slip down by the two channels, *o o*, into the arc chamber, *b*. In this chamber they are submitted to a preliminary heating by the arcs formed between the two sets of carbon poles, *h h*, and the two streams of half-molten material which pass from this chamber unite at *f*, and flow on to the third arc at *k*. Here a second and final heating of the mass occurs, and the completely melted glass flows on into the division of the furnace tank marked *m*. A hanging wall and bridge separate this from the second division of the furnace, *n*, into which the glass passes free from bubbles of gas and ready for use.

The experiments with this form of furnace proved that the manufacture of glass in this way was practicable, but that a longer period of heating was necessary in order to obtain glass perfectly free from mechanically held bubbles of gas. This further heating can be most economically supplied by building gas flues in the

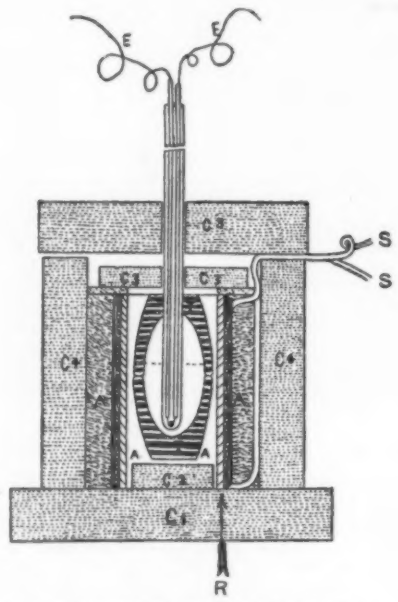


Fig. 3—THE HOLBORN ELECTRIC FURNACE

walls of the furnace body, and by using fuel gas for this purpose. As a result of the presence of sodium salts in the glass mixture before melting, and the volatilization of these salts in the electric arc, it was possible to obtain arcs 3 centimeters in length, with an E. M. F. of only 40 volts. A current of 150 amperes at this voltage sufficed to work the furnace shown. As melted glass is an electrolyte, it is necessary to use alternating currents for the melting operation. The electric furnace method of glass production is stated by Bermbach to overcome the following disadvantages of the older process: (1) Costly furnaces; (2) heavy repairs; (3) short life of furnaces; (4) intermittent work; (5) unhealthiness.

Disadvantages 4 and 5, however, only attend the working of pot furnaces, and it is yet too early to say whether any special disadvantages are allied to the operation of the Becker electric furnace. The wear and tear in the arc portion of this furnace is likely to be heavy, and the charges of maintenance and repairs may be as great as in the present form of tank furnace. It has already been pointed out that the electric furnace, if successful in glass manufacture, is likely to be first worked industrially in the districts and localities where cheap electric power is available, and for the present the supremacy of the tank furnace in those countries that possess cheap fuel is not seriously threatened.

We also illustrate two new forms of electric furnace for laboratory use. The principle underlying the use of these is that of applying resistance heating, in place of the more usual arc heating, for attaining temperatures ranging up to 1,500 deg. Cent. in a small confined space. The resistances used have been made of nickel or platinum wire, and are in the form of spirals wound round thin fire-clay or porcelain cylinders. The furnace shown in sectional elevation in Fig. 3 was designed by Prof. Holborn, of the Reichsanstalt, Berlin. C_1 is a round base plate, upon which is supported a cylinder, C_2, and a round flat cover, C_3, all these portions being of fire-clay or some similar material. *R* is a thin cylinder of porcelain, upon which is wound the spiral of nickel or platinum wire conveying the current. *R* is closed above and below by the round fire-clay blocks, C_2 and C_3, and in its interior the crucible, *T*, to be heated is placed. The figure also shows a special form of pyrometer used with these furnaces, in position. The space, *A A*, between the resistance spiral and the outer wall of the furnace, is filled with asbestos or finely divided quartz.

In the No. 1 furnace the resistance spiral consists of 9 millimeters of nickel wire 0.6 millimeter in diameter, and a temperature of 1,000 deg. Cent. can be attained with a current of 5.5 amperes at 110 volts. In the Nos. 2 and 3 furnaces platinum is substituted for nickel, and a current of 11 amperes at 110 volts suffices to produce a temperature of 1,200 deg. Cent. The spiral in this case consists of 8 meters platinum wire of 0.34 millimeter diameter. By increasing the current to 13½ amperes, and the length of the wire to 9 meters, a temperature of 1,300 deg. Cent. can be attained.

Fig. 4 shows a perspective view of the second form in which these furnaces are made. *A A* is the porcelain tube carrying the resistance spiral, *B* is a cylinder of sheet iron filled with asbestos or powdered quartz, and *E F* are the current connections. *R* is a narrow porcelain tube carrying the thermo-element by which the temperature is ascertained. The material to be heated is placed in the center portion of the porcelain

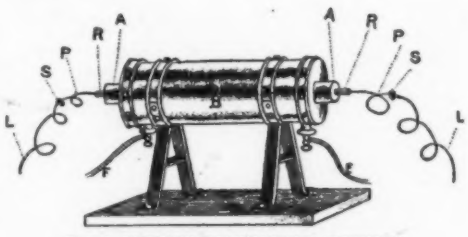


Fig. 4—HORIZONTAL ELECTRIC FURNACE

tube, *A*, bearing the spiral, and when necessary the air can be excluded from this tube, and the heating carried on in any desired gas or gaseous mixture. This tube is usually made 44 centimeters in length by 2 centimeters in diameter. With a nickel heating spiral—12 meters of 0.85 millimeter wire—and a current of 7.3 amperes at 110 volts, a temperature of 1,000 deg. Cent. can be attained in this form of furnace. Substituting 8 meters of 0.35 millimeter platinum wire, 9 amperes at 110 volts give a temperature of 1,200 deg. Cent. In the largest furnace of this type the inner heating tube is of the best Berlin porcelain, and is protected by an outer fire-clay tube. Using a current of 14 amperes at 110 volts, a temperature of 1,500 deg. Cent. can be attained at the end of 1½ hours' use.

The advantages claimed for this type of electric furnace are cleanliness and easy regulation of the temperature. When heating is first commenced the insertion of a resistance coil in the circuit is necessary, and by manipulation of this coil the temperature can be regulated as desired. The various parts of the furnaces can be replaced when no longer fit for use by Heraeus, of Hanau, the firm who have undertaken their manufacture.

COAL-SAVING DEVICES.

WITH anthracite coal selling at unspeakable prices, the ingenuity of the householder in the Eastern States has been taxed to the utmost to heat his home efficiently and yet economically. Many of the schemes adopted during the strike were certainly bizarre. Kerosene in one form or another was widely used. Bricks soaked in the oil were found to burn effectively, but were not quite as odorless as the newspapers claimed. Several new contrivances for using gas in cooking stoves were introduced. A large asbestos manufacturing firm is said to have provided a specially prepared asbestos brick which it was claimed would do two hours' cooking and baking for an ordinary family with one quart of oil. But it is doubtful whether great economy could thereby be obtained.

Many a householder flattered himself that even though coal became so scarce that it could not be obtained, he would simply have to burn oil in order to keep warm. But the truth is that there are very few oil-burning devices which can be applied to the ordinary stove. Indeed, how few oil-burners were used was shown by the immense demand made during the strike and the inability of the manufacturers to meet that demand. There is here a chance for some ingenious inventor; for even though the coal strike is over, oil will secure a permanent place as a household fuel. The three chief points in perfecting large burners are per-

fect combustion, no odor, and no smoke. Noiselessness and safety are other considerations which must be kept in view.

Oil-stoves have, of course, been known and are even widely used. One large company, for example, annually sells many thousands, and the demand during the coal strike was such that the works could not possibly cope with it. An oil stove for heating and cooking is sold from $3 to $10, and a stove large enough to heat a room 16 by 18 feet in size burns one gallon of oil in ten hours, making the cost about one cent an hour. The heaters have a wide flame showing that equal parts of oxygen and fuel are being burned. The cooking stove uses about an equal amount of oil but produces a blue flame. Kitchens in which they are used must be well ventilated, for they burn about seven times as much oxygen as the heaters. Briquette fuel is very widely used in Germany; and for that reason our United States Consul General at Berlin received many inquiries during the strike regarding the manufacture of these briquettes. In Germany many tons of this artificial fuel are annually consumed. Briquettes are made from brown coal, carbonized peat, coal dust, or saw-dust. They are considered a good fuel in Germany and other parts of Europe, and are much cheaper than coal, besides producing no smoke. At the close of 1900 there were in Germany eighty-nine factories of fuel briquettes of which several produced more than 100,000 tons annually.

Correspondence.

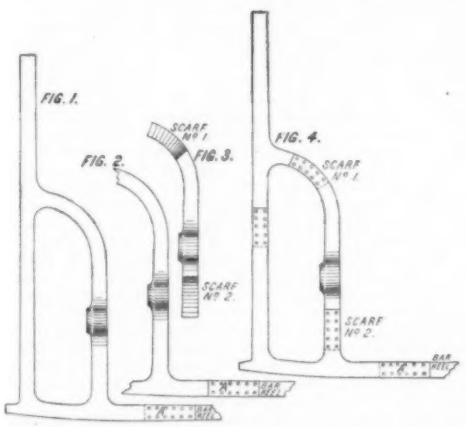
PNEUMATIC TOOLS—THEIR USE AND CAPABILITIES.

To the Editor of the SCIENTIFIC AMERICAN:

Having lately seen a very heavy piece of marine engineering successfully carried out with the help of pneumatic tools, I think that perhaps a short description of the way the work was done and of the accident which necessitated it might be of interest to your readers.

As reported by the press, the Cunarder "Etruria" lost her propeller in mid-ocean while on her passage from this port toward Liverpool in the month of March last. She was fortunately spoken by the steamship "Robert Cliff," and towed by that ship to the Azores, and from there to Liverpool by tugs sent out for that purpose.

The weather at the time of the accident was fine, and



STERN FRAME OF THE "ETRURIA," SHOWING THE METHOD OF REPAIRS ADOPTED.

the sea smooth, the "Etruria" was going along at her usual rate of speed, from 19 to 20 knots an hour, her engines making 62 turns per minute. All at once the engineers noticed that something was wrong, but could not locate the cause, the only indication being an unusual noise coming from the stern-tube. The chief engineer, however, decided to slow down the engine to half speed, and the instant this was done the propeller fell off, taking with it the rudder post and rudder.

On the ship's arrival in Liverpool, she was at once put into the Canada graving dock, and then the mystery attending the accident was fully explained. The tail shaft had broken somewhat in the form of a scarf, part of which was in the hub of the propeller, and this was sufficient for the time being to keep it (the hub) revolving with the engine, which was running at its normal speed; but just as soon as the engine was slowed down, the ship, which was still going through the water at her normal speed, drew away from and may be said to have left the propeller behind, and then the scarfed end of the tail shaft was drawn out of the hub, and of course the propeller went down.

The "Etruria's" propeller is 26 feet in diameter, and weighs 40 tons, so it can be imagined with what force it struck the rudder post, or rather, the force with which the rudder post was drawn against it.

I append a few rough sketches without any attempt at proportion, which may help to make the description more readily understood.

Fig. 1 shows the frame as it was before the accident, a one-piece forging.

Fig. 2 shows what was left of the frame after the accident.

Fig. 3 shows the part of the frame which was retained with the scarfs cut ready to be united to the new parts.

Fig. 4 shows the finished frame with the old and new parts riveted together.

It being found that the most important part of the frame, that part in which the shaft bearing is located, was quite uninjured, it was decided to leave it in place and to attach new parts to it by means of scarfs and rivets. The first thing therefore done was to strip off the plating, so that scarfs could be cut as shown in Fig. 3, and also to get at the rivets uniting the frame to the old-fashioned "bar" keel. This part is marked *A* on the sketches. The cutting asunder of the frame where scarf No. 2 was made was a very heavy job, as at that part it measures 17 x 11 inches. It was done with pneumatic drilling tools, which were worked from forward and aft; the 1¼-inch holes, which were bored at the rate of 1 inch per minute, meeting in the middle.

It not being possible to bore these holes so accurately as to cut away all the iron, thin walls were in places left between the holes, but these were afterward burst asunder by means of steel drift pins. The pneumatic chipping tools were then used to cut down the ridges left between the holes, and afterward an improvised planing machine made a good flat and smooth surface.

While this work was being done in Liverpool, the new parts were being forged and fitted in Glasgow, where the ship was built. It will be seen from Fig. 4 that the new rudder post was made in two pieces. This was done partly to facilitate transportation to Liverpool by rail, and also because, had it been made in one length, it could not have been put in place without taking down part of the counter or stern structure.

All the rivet holes in the scarfs in the new parts were bored and countersunk in Glasgow, with the exception of those in the part marked *A*, which had to be marked off from the original holes in the bar keel, and were therefore bored in the dock.

When the new parts were set up in place, they were found to fit most accurately. The rivet holes were marked off in the old part and bored, then both parts, old and new, were clamped together and the holes reamed out, both of these operations being done by the pneumatic drilling machine. The rivets, which were all "turned up" with countersunk heads, were then riveted by the pneumatic riveter.

The time consumed in doing this work was about five weeks, and it is my belief that without the pneumatic tools it could not have been done in double that time.

I think it is well known to marine engineers that in most cases, when stern frames are carried away from any cause whatever, they give out at the welds; but as it is not possible to forge them without welding, it would seem that a built-up frame such as is the "Etruria's" at present, is the better of the two. It is true that there are probably as many welds in it as formerly; but as the pieces of which it is made up are comparatively small and easily handled, welds in it are much more likely to be sound than when it is attempted to make the entire frame in one piece.

Taking this view of it, I am inclined to think that the "Etruria's" stern frame is now quite as strong, if not stronger, than was the original one.

New York, August 25, 1902. W. E. CARLILE.

CORE-WIRE STRAIGHTENING MACHINE.

WE illustrate the "Climax" core-wire straightening machine, invented by Messrs. George de Laval, Cambridge, and Charles W. Chisholm, Somerville, Mass., and manufactured at the Blake & Knowles Steam Pump Works. From the general elevation and cross section (Fig. 2) the principle of the machine will be understood. The rolls, as shown in the detail (Fig. 3), are provided with registering grooves shaped to suit various wire gauges, and corrugated to firmly grip the rods passing through the rolls. While the lower roll is stationary, the bearing-boxes of the upper roll are movable, and are acted on by the springs shown in the section to regulate the pressure.

The bending device, through which the rods are drawn by the rolls, comprises a cylindrical guiding passage in the front plate, of substantially the diameter of the rods to be straightened, and a surrounding bending surface in front of the guiding passage, but out of line with it, so that it will act upon the rod to one side of the line of force drawing the rod through the cylindrical guide. The bending surface converges toward the central passage, and forms a cam surface, which surrounds the rod and engages any part which may be bent or out of line with the passage, and directs such bent part into line. As this cam or bending surface surrounds the rod passing through the passage, it will act equally well upon all sides. The bending device is made in the form of a bushing, provided with a central bore having a bell mouth, and is mounted in a hole in the front plate. It is held against forward movement by a flange, which engages the front face of the plate, forming a rigid abutment for resisting the heavy strain put upon the bushing in drawing the rod through. With this construction the bushing is effectively supported to resist the heavy strain put upon it, and may still be readily removed to allow access to the rolls. In the rear of the rolls a guide is arranged so that it receives the end of the rod as it comes from the rolls and causes it and the following parts of the rod to travel in a straight line. This guide is in the form of a cylindrical passage, the size of the rod being acted upon, and provided with a bell mouth arranged in close proximity to the rolls. Should the wire be deflected out of line by the action of the rolls, it will thus be directed into the cylindrical part of the guide. The guide is made in a bushing mounted in a hole in the rear plate, and the locking device is so arranged that it may be readily removed to give access to the rolls. A simple and convenient form of locking device is that shown by Figs. 4 and 5, which consists of a U-shaped bar, the legs of which pass through grooves in the rear plate of the machine and through slots formed in the bushings, the bars being held in the grooves by a plate shown in section at the outer edge of the aperture in the rear plate, where the rods leave the rolls The bushing is rigidly held in place by the locking-bar, which may be readily removed to allow the bushing to be drawn out when desired.—Engineering.

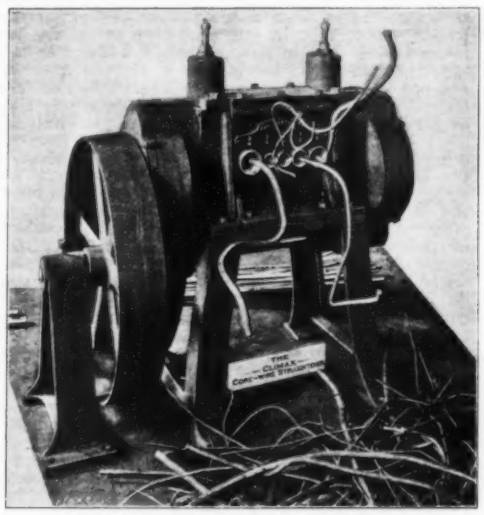
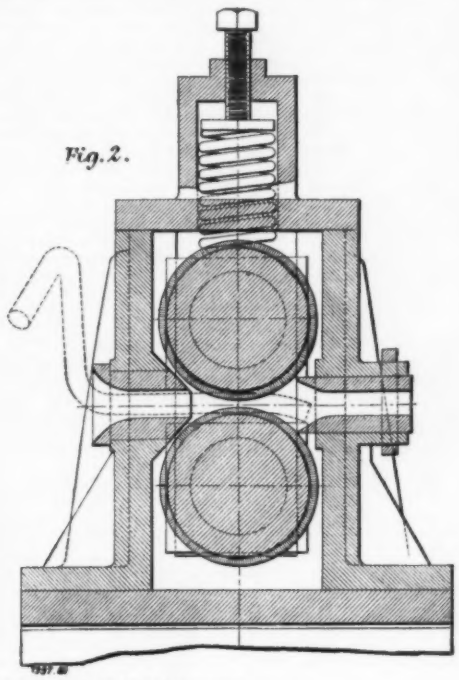
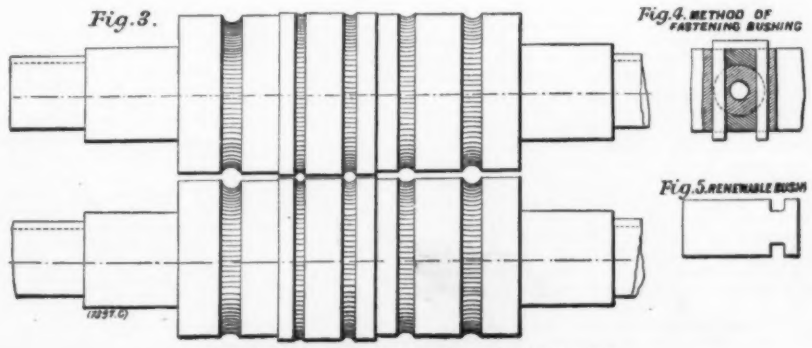


Fig. 2.



FIGS. 1 AND 2.—CORE-WIRE STRAIGHTENING MACHINE.



CORE-WIRE STRAIGHTENING MACHINE.

ANTHRACITE'S DOWNS AND UPS.

ANTHRACITE coal, which we are all so anxious to get just now, was less than a century ago, when the first efforts were made to market it, denounced as a fraud. The people of those days declared it was impossible to burn such "stone." At the close of the eighteenth century, in 1791, the Lehigh Coal Company tried in vain to sell in Philadelphia the new fuel which had been found on its property in Carbon County. Several attempts were made to burn anthracite, but for a long

time the results were uniformly unsatisfactory. Finally, in 1815, the secret was accidentally discovered. Tests had been made in a rolling mill at Schuylkill. After repeated attempts to make it burn by means of frequently raking the fire, the workmen gave up the experiment in disgust, filled the furnace with the worthless "black stones" and left it. Returning a few hours afterward, they were amazed to find a fierce fire with a terrific heat, and thenceforward the problem of burning anthracite was solved.

But the people were slow to believe that it was possible to get heat by burning the black stones. As late as 1833 one Charles Miner wrote as follows: "While we pushed forward our labors at the mine, hauling coal, building arks, etc., we had the greater difficulty to overcome of inducing the public to use our coal when brought to their doors, much as it was needed. We published hand bills in English and German, stating the mode of burning the coal, either in grates, smiths' fires or in stoves. Numerous certificates were obtained and printed from blacksmiths and others who had successfully used the anthracite. Mr. Cist formed a model of a coal stove and got a number cast. Together we went to the several houses in the city and prevailed on the masters to allow us to kindle fires of anthracite in their grates, erected to burn Liverpool coal. We attended at blacksmiths' shops and persuaded some to alter the 'too-iron,' so that they might burn the Lehigh coal; and we were sometimes obliged to bribe the journeymen to try the experiment fairly, so averse were they to learning the use of a new sort of fuel so different from what they were accustomed to."

But even these methods were slow to overcome popular prejudice. It was only when, through a sudden rise in the price of charcoal, the manufacturers began to use anthracite that the new fuel found its way into favor.—Toronto Post and Express.

RECENT DEVELOPMENTS IN COLORING MATTERS.*

GEHEIMRATH PROFESSOR OTTO N. WITT, Ph.D., F.C.S., of Berlin.

THE love of color is innate in the human mind, and this alone, if nothing else, would be sufficient to account for the interest with which the coal-tar color industry has met from its beginning. In England especially its progress has been watched with great attention, and only two days ago the Vice-Patron of this institution, His Royal Highness the Prince of Wales, has shown by some remarks, made in his opening address of the New Technical Institute at Bushey, that the interest taken in this subject has in no way abated.

Artificial coloring matters have formed so often the subject of more or less popular lectures, and this subject has been treated with such ability by eminent scientists, that it becomes difficult to show this domain of chemistry in a light new and interesting to an audience such as I have to-day the honor to address. Many years ago you have seen in this room the early achievements of the newly-created industry, marvelous for their beauty and brilliancy. Later on the progress of this industry has been duly recorded. More recently still it has become the custom in this country to view color making not so much from its chemical or industrial side, as from the standpoint of the national economist, who contemplates the values produced by industrial enterprise, and investigates the reasons why these values should be unevenly distributed among the different nations, striving side by side for progress and engaged in friendly, yet none the less eager, competition.

I may say at once, that I have no intention to treat my subject from either of these points of view. I take it for granted, that everybody is acquainted with the marvelous variety and brilliancy of artificial dyestuffs, and I am too much of a chemist and too little of an economist to offer any original or valuable view about that side of the question which I have just mentioned. But I shall make an attempt to trace in this lecture the influence of the development of theoretical chemistry on the progress of the color industry. If in so doing, I should refer now and then to theoretical points without being able to explain them in detail, I hope to be forgiven.

In beginning this lecture allow me briefly to refer to the history of it.

When I received from Sir William Crookes the flattering invitation to speak before you this evening, my thoughts naturally wandered back to some recollections in connection with this institution. I remembered vividly several brilliant lectures to which I had the privilege of listening in this room, where the spirits of Davy and Faraday, of Graham and Huxley, of Würtz and of my immortal friend A. W. von Hofmann seem still to be hovering. I felt loth to raise my own voice in such hallowed precincts. But then I also remembered an almost forgotten episode in my own life, which I ask your permission to tell.

I remembered that almost exactly five-and-twenty years before receiving this invitation, I, then a very young chemist, had read before the Chemical Society of London, a paper containing a then somewhat daring speculation on the connection of the constitution of coloring matters with their properties, a paper which the publication committee refused to print. A lively discussion followed, which was wound up by some encouraging remarks from the president, the late Mr. De la Rue. He said that he hoped that this speculative paper would prove useful in clearing up the complicated domain of coloring matters and that perhaps on some future occasion I should be in a position to place before the world, in a Royal Institution lecture, the results which had been obtained by its help.

This strange reminiscence, coupled with the curious fact that Mr. De la Rue's prophetic words were fulfilled just when the period commonly assigned to a jubilee had elapsed, gave me the courage to accept Sir William's kind invitation. For though I have done comparatively little toward the increase of our knowledge of coloring matters, the five-and-twenty years past have sufficed to shed a brilliant light on what Mr. De la Rue could then justly call a very imperfectly known domain of chemistry, and innumerable facts brought to light during this period by a whole army of assiduous workers are now by common assent being classified under a theory which is neither more nor less than the suggestions contained in that rejected paper of mine, which I had fortunately published in another journal.

I may add that I have been guilty in later times of another theory, which refers to the domain of dyeing, and which has still many opponents. This theory is the direct outcome of the theory of coloring matters, and may be illustrated by some simple, yet striking experiments, some of which I intend to show you.

A fundamental question in the chemistry of dyestuffs, and one not at all easy to answer, is this: "What is a dye-stuff?" Clearly it is something totally different from a substance only endowed with the power of selective absorption of light, a power which causes it to appear colored. We know now that there are more substances in creation which possess this power than bodies which lack it. In this very room we have learned that the air itself, through which the solar rays penetrate on to the surface of the earth, is blue, and not colorless, as we used to think. But even if we leave out of the question such faintly colored substances as air and water, if we restrict our consideration to compounds endowed with a very intense power of selective absorption and at the same time soluble in the water which we employ for preparing our dye-baths, we do not arrive yet at the true definition of the dye-stuff. Cupric salts, soluble chromates and many other intensely-colored bodies are no dye-stuffs, as may be easily shown by experiment. Yet these compounds penetrate into the interior of textile fibers which are immersed into their solution. They must do so, according to the laws of Osmose so ably expounded by Thomas Graham, because they are crystalloids and the fibers are invariably colloids.

We know now that the laws of Osmose are identical with the laws governing solution, and that crystalloids are able to wander into the interior of colloids because they are soluble in their substance. Osmotic processes may be observed between two liquids which cannot be mixed with each other, just as well as between a liquid and a colloid immersed into it. Consequently we are justified in assuming that the same powers are at work in both cases.

In my first experiment (Exp. I.)* I intend to show you that a crystalloid, dissolved in some liquid such as water, and brought into contact with another liquid, not miscible with the first, such as ether, will remain indifferent to the ether altogether, or it will leave the water and wander into the ether, or it will be distributed according to a certain ratio between the two solvents. In this latter case we have reason to believe that a constant interchange of molecules takes place between the two solutions. Clearly, this will only happen if there exists no great difference in the solubilities of the crystalloid in water and in ether. In that case the water will continually abstract nearly as many molecules of the crystalloid from the ether as the latter will take up from the water, and thus an equilibrium will be reached. If, on the other side, there is a great dissimilarity in the solubility of the crystalloid in the two solvents, then this process of mutual interchange will become so one-sided that it practically amounts to the absorption of the whole of the crystalloid by one of the solvents.

My second experiment (Exp. II.)† is a more striking illustration of these fundamental facts. If we mix together two colored solutions, one an aqueous one of a substance much more soluble in ether than in water, and the other an ethereal one of a substance more soluble in water than in ether, then the two solutions, on shaking, change color, and their shades are reversed.

According to my theory, the process of dyeing, considered so problematical by many experts in this ancient and useful art, is strictly analogous with this wandering of molecules governed by the laws of solution, which we can so easily observe and control in operating with two non-miscible liquid solvents.

In my next experiment (Exp. III)‡ we see that a dye stuff wanders from the bath on to the fiber in much the same way as it wandered from water into ether. And if the fiber be previously dyed with a coloring matter little soluble in its substance, then this may be expelled and replaced by another of greater solubility. (Exp. IV.)

We see now that, in order to become a dye stuff, a substance must not only be so intensely colored that it can communicate its own shade to colorless substances holding it in solution; it must not only be soluble in water or any other liquid suitable for preparing a dye bath; but it must also be soluble, and even much more soluble than in water, in the colloid, which forms the substance of the textile fiber. The finished dyed fabric is nothing more nor less than a solid solution of the dye stuff in the substance of the fiber, unless there are secondary chemical influences, such as that of the mordants, at work, which change the solution into a suspension by precipitating the dye stuff after its immigration into the fiber.

This peculiar combination of solubilities is very rarely met with among the colored substances of an anorganic nature. In the vast domain of organic compounds of the aliphatic series we meet with very few dye stuffs, because its members are mostly colorless, or but very faintly colored. In the aromatic series, on the contrary, the power of selective absorption of light is so very frequent, that it would be very curious indeed if just that combination of solubilities, which is the making of the dye stuff, were not of common occurrence. Taking as a basis the universally admitted axiom, that the physical properties of every compound are direct functions of its molecular constitution, we may easily believe that that peculiar combination of solubilities which I have shown to be the characteristic feature of the dye stuff, would be the result of certain general conditions fulfilled in the constitution of many members of the aromatic group. My theory, proposed five-and-twenty years ago, was nothing else than an attempt to ascertain these general conditions by investigating the constitutional peculiarities of all those dye stuffs the constitution of which had been fully established in those days.

I have no intention to tax your patience by explaining in detail the results of that old investigation. It will be sufficient to summarize them by saying that in the molecule of every coloring matter, the constitution of which has been ascertained to this day (and there are many thousands of them), certain atomic constellations have been observed which seem to be essential, and of which always two must be present. One of these constellations is a group of atoms, which is the cause of the selective absorption of light. This group of atoms I called a *chromophore*. The number of atomic groups endowed with chromophoric properties amounts at present to about two dozen, and is being constantly increased by the progress of chemical research. All the chromophores, however, have that in common, that they are unable to exert their influence unless they are helped by the presence of another group of atoms, which I call the *auxochromic* group. Very few auxochromic groups are known, and they belong to those which occur most frequently in the whole domain of organic chemistry—the amino group in its various forms, the hydroxyl group occurring in all the phenols, the sulpho and the carboxyl group. None of these will cause a substance to become a dye stuff unless this substance also contain a chromophore, but the latter is equally helpless if deprived of the assistance of the auxochromic group. Thus we meet in the molecular world that condition of the necessity of mutual help and assistance between two heterogeneous forms, which we can also trace in sociology, a fact the establishment of which will no doubt be greeted with satisfaction by the ladies in this audience.

Our ideas on the nature and constitution of those groups which may act as chromophores have of course undergone many changes. Undoubtedly there must exist a law which governs the formation of chromophoric groups, but so far this law has not been definitely established. Some progress has, however, been made toward this end. At first the chromophores which we had gradually collected formed rather a motley crowd, and seemed to have no points in common. At present chemists working in this domain are inclined to attribute a quinoid structure to the great majority of coloring matters. If this view be correct, then all these substances would be derivatives, not of benzene and its congeners, but of hydrocarbons containing two hydrogen atoms more in their molecule, derived from dihydrobenzene as a prototype. As sometimes it is almost impossible to decide in favor of one view or the other, the convenient hypothesis of tautomerism was resorted to, but in some cases we have been able to establish definitely the quinoid formula. Such is the case with the large and brilliantly colored group of dye stuffs called phtaleines, which, according to modern view, must be considered as quinoid derivatives of benzoylbenzoic acid. The experiments which lead to this conclusion are so striking, that I cannot refrain from producing one of them, which has never been shown yet, though the time at my disposal does not allow its exhaustive discussion from a theoretical point of view. If we dissolve the well-known phenolphtaleine in anhydrous ether containing some ammonia, the solution is perfectly colorless, but if we add ordinary water to this solution (Exp. V.), it assumes a beautiful red coloration. This peculiar fact that water alone is sufficient to cause the formation of this color is perfectly incomprehensible if the old views on the constitution of phtaleines, which are still given in the majority of text-books, be adhered to, but it is exactly what we might expect to happen if we assume that the ammonium salt of phenolphtaleine possesses a cycloid constitution in its ethereal solution, and that it is isomerized into the quinonoid form by the addition of water.

Thus our knowledge of the chemical causes of the physical properties of coloring matters is continuously developing. Quite lately we have even begun to form definite views about the connection of the chemical constitution of aromatic substances with that peculiar form of selective absorption of light which we call fluorescence, and which has formed, from the physical point of view, the subject of the masterly investigations of Sir Gabriel Stokes. The phenomenon of fluorescence is very frequently met with in dye stuffs, and in the raw materials used for their manufacture. It can be exhibited in a very striking way with the help of electricity, either by allowing an arrow of electric light to penetrate into the solution of a fluorescent substance or by working a Geissler tube of suitable shape submerged in such a solution (Exp. VI.). The fact that the fluorescence of many substances is chiefly caused by the ultra-violet light, I shall try to demonstrate by the following, somewhat delicate, experiment: I have here, submerged in a solution of eosine, a Geissler tube, the lower part of which is ground out of a piece of rock crystal, while the upper half is made of glass. When the electric current passes this tube the fluorescence round the quartz part of it is stronger than that in the neighborhood of the glass, because the latter absorbs a good deal of ultra-violet light, while the quartz is almost free from such absorption. (Exp. VII.)

An immense amount of patient work has been accomplished by many chemists in the hope of establishing definite views on the constitution of the azo-colors, that group of dye stuffs the introduction of which into the color industry was the direct consequence of our early efforts to cast off empiricism, and to conduct our search for new coloring matters according to definite scientific principles. Simple and transparent as the constitution of azo-colors appears to be if viewed superficially, yet it offers some problems of extraordinary difficulty, which have not been solved so far. But

* Paper read before the Royal Institution of Great Britain.

* Details of experiment: An aqueous solution of magenta does not yield its coloring-matter to ether; indophenol, on the contrary, is entirely taken up by ether. The dye-stuff, which is partly taken up by ether, is also a member of the indophenol group, the constitution of which is not yet fully established.

† The ethereal solution used contained magenta acetate, while the aqueous one was prepared with trichloro-indophenol.

‡ In Exp. III. wool was dyed with erythrosine in the ordinary way, while in Exp. IV. a cotton cloth, previously dyed with patent blue, was treated in a bath of Congo red.

fortunately these difficulties have in no way interfered with the technical development of this family of dye stuffs, which has been for a whole quarter of a century one continued and unparalleled series of successes. The process for producing these dye stuffs is of the greatest simplicity. It consists in pouring together (Exp. VIII.) cold aqueous solutions or suspensions of diazo-compounds and phenols or amines. The dye-stuff is formed at once in a state of absolute purity, and with a yield absolutely theoretical; it need only be collected and dried to form a salable product. No wonder, then, that these dye stuffs gradually became the leading ones, and to a great extent superseded the old empirical products which were concocted in many complicated operations, with yields very far from satisfactory. As the number of diazo-compounds and of phenols and amines at our disposal is very large, the number of dye stuffs which may thus be prepared is quite extraordinary; it has been computed, according to the rules of permutation. 3,159,000 different individual dye stuffs have thus been proved to be at present easily accessible to our industry. Of these at least 25,000 form the subject of German patent specifications and of corresponding specifications in England, France, the United States and other countries. Over five hundred are regularly manufactured on the larger scale.

The prolific nature of the azo-color reaction explains the fact, that in this group we can choose, much better than in any other, substances possessing that ratio of solubilities in water and in the colloid substance of the various textile fibers, which we require. We can produce, quite at will, azo-dye stuffs which dye wool or silk or cotton, which dye slowly or quickly, which will stand soap or acid or alkali. This possibility of adjusting the chemical properties of dye stuffs with an almost mechanical precision has been the cause of one of the greatest successes of the color industry, the introduction of what is now known under the name of "substantive dye stuffs," an expression which means dye stuffs that will dye cotton and other vegetable fibers from a simple aqueous dye bath without the use of any mordant. The difference of the solvent power of cellulose and of water is for the vast majority of dye stuffs so small, that the process of dyeing vegetable fibers with these ordinary coloring matters can only be compared to that case of the joint action of ether and water on some substance soluble in both these solvents, where an almost equal division of this substance takes place between the two solvents. Such cases exist, as you saw in the first experiment. It is among the azo-dyes that we have found compounds which are so much more soluble in cellulose than in water, that they readily leave their aqueous solution and take up their abode in the fiber. And we have not only found these dye stuffs but also the law which governs this most valuable abnormal solubility: it appears in all azo-colors, which are prepared with diazo-compounds derived from symmetrical para-diamines. A novel and extremely fertile field for a systematic search for new dye stuffs was thus opened, a field which has occupied hundreds of busy workers for many years, many of whom carried home a rich reward.

But while this field bore its rich harvest, others were by no means neglected. The search for dye stuffs, which will dye cotton without a mordant, could not make us forget that just those coloring matters which imperatively demand the use of mordants are those which from time immemorial have been used in preference for the production of fast and lasting shades. The brilliant synthesis of alizarine by Graebe and Liebermann, which made the world ring with admiration early in the seventies, had given us ample proof that the old and to this day not wholly forgotten axiom, that there are two kinds of dyes, natural ones, which are fast, and artificial ones, which are fugitive, was a preconceived idea, totally devoid of any scientific foundation. The enormous financial success of the alizarine industry formed a tempting invitation to search for other dye stuffs, which, similar to alizarine, would be endowed with the power of forming almost indestructible lakes with mordants of a sesquioxydic nature. Here, too, like everywhere in science, we have marched for some time on the paths of empiricism, but here, too, logical deduction has come to our aid in disclosing the laws which govern the formation of lakes. In this case it is not (as in the substantive azo-dyes) the carbonic nucleus which determines the *physical* properties (viz., the ratio of solubility) of the dye stuff, but it is the peculiar position of the auxochromic groups contained in the molecule, which governs its chemical properties. We know now, that a dye stuff must contain, in order to be able to form lakes with sesquioxydic mordants, two hydroxyl groups in juxtaposition. If this condition be fulfilled, the dye stuff will dye in the same way and with equal fastness as alizarine, even if it be no derivative of anthracene, like the early alizarine dyes; and if these two hydroxyl groups or a suitable equivalent for them be missing it will lack all power of dyeing mordants, even though derived from anthracene. With this law once established the synthesis of mordant dye stuffs became a very easy matter, and to-day there is hardly a group of coloring matters in which there are not some members possessed of this peculiarity and owing it to the same uniform cause. Still the group of the oxyketones, to which alizarine itself belongs, remains the true home of mordant dyes, but this group has grown to-day into a very numerous and varied one. Mordant dyes of every shade are to be found in it, and cotton is no longer the only fiber to which such dyes are applied. It is a fact worthy of notice that among the many dyes of this class which we now possess and the constitution of which is fully established there is not a small number, the molecule of which contains three, four, five or even six hydroxyl groups. Yet this increase of auxochromic groups does not influence in the least the behavior of these dyes to mordants, this is only governed by the two hydroxyl groups in ortho-position, and any other such group introduced into the molecule only changes the shade, not the characteristic chemical properties.

A greater variety still than by the achievements of modern synthetical work will come into this group of mordant dyes by the progress of the elucidation of the constitution of the natural dye stuffs occurring in roots, barks and woods. A good many of them are still unsolved mysteries, but there can be no doubt that they owe, like alizarine, purpurine and the other madder dye stuffs, their property of dyeing metallic mordants to the presence of hydroxyl groups in ortho-position in their molecule.

A very large and varied group of coloring matters, which for a long time resisted all attempts at unraveling their constitution, are the Saffranines, Eurhodines, Oxazines, Thionines, Indulines and other allied groups. They are now completely understood, and have been recognized as the animo and oxy-derivatives of certain peculiar substances such as the azines and azonium bases, the molecule of which possesses a ring structure. Here no longer carbon atoms only form the closed chain, but nitrogen, oxygen and even sulphur atoms participate in its structure and bring about the peculiar properties of the compounds. When this fact was at first ascertained it seemed sufficient for the explanation of the behavior of such compounds as dyes. It was only somewhat later on that we recognized that in these classes of dye stuffs especially a quinonoid structure is essential.

The greatest and most brilliant success of the chemistry of dye stuffs is, however, the industrial synthesis of indigo. This offers so many points of general interest, that I am sure to meet with your approval if I refer to it in some detail.

The indigo problem is one of the oldest problems of chemistry. When Baeyer took it up more than thirty years ago he found the ground well prepared by others who had worked before him. But his is the merit of having completely elucidated the constitution of this extraordinary product of nature. He and others have also shown various methods for the synthesis or artificial production of indigo. In the laboratories artificial indigo has been known for the last twenty years.

But in this case the scientific synthesis of a natural product proved to be by no means identical with the industrial one. Industrial methods can only enter into competition with nature if they work more economically than nature does. In the case of indigo there seemed to be little hope for fulfilling this condition. The most enthusiastic admirers of the modern synthetical industry could not help seeing that all evidence in our hands went against the probability of the practical synthesis of indigo, and just those who understood most of these things could least of all close their eyes to that fact. It could not be denied that every possible synthesis of indigo, those known as well as those which might still be expected, had to start from some aromatic derivative of benzene, containing one carbonic and one nitrogenous side-chain in ortho-position. Of all the products at our disposal which fulfill that condition, ortho-nitrotoluene is the most easily accessible. Now, taking it for granted that indigo could be prepared regularly and with good yields from ortho-nitrotoluene, there still remained that difficulty, that all the toluene produced in the world, even if we suppose that all the other uses to which this hydrocarbon is put at present could be suppressed, would not suffice for the production of the world's consumption of indigo.

If, under such circumstances, the industry of artificial dye stuffs continued to work at the indigo problem, it did so more for the general interest attached to it, and with a view to securing some of the finer applications of indigo in printing, than in the hope of being able to compete with the natural product in the great consumption of vat dyeing. If, on the other hand, the indigo planters in the far East showed but small apprehension of the danger of which they were occasionally warned, we cannot blame them for it; they had, no doubt, taken the advice of competent people, and these had told them what was correct according to the knowledge of the time.

The final result has shown all the calculations of experts to be wrong, but in such a way that they, too, can surely not be blamed for the error they committed.

The process by which indigo is at present manufactured on a colossal scale by the Badische Anilin und Soda-Fabrik in Ludwigshafen on the Rhine, is based on Heumann's synthesis of this most important dye stuff, which consists in submitting phenylglycine to a fusion with caustic alkali. Phenylglycine is prepared by the action of monochloracetic acid upon aniline. The yield of indigo obtained is a poor one, but it can be very much improved if, instead of phenylglycine, we take its orthocarbonic acid. In this we have again the presence of a nitrogenous and a carbonic side-chain in ortho-position. To prepare this acid we should have to start, according to the ordinary rules, from toluene, transforming it by a succession of operations. Thus we come again to toluene as a starting point, and to the difficulty already explained.

There is, however, one somewhat abnormal process of preparing the same compound from phtalic acid. It consists in converting this into phtalimide, and treating the latter with sodium hypochlorite. By a somewhat complicated reaction, the nature of which need not be explained, one of the carboxyl groups of the phtalic acid is replaced by the amido group, anthranilic acid is formed, and this, if treated with monochloracetic acid, yields phenylglycine-carbonic acid, which has proved so important for the manufacture of indigo. Now phtalic acid is prepared by a powerful oxydation of naphthalene, and naphthalene again is that constituent of coal-tar which is present in by far the largest quantity.

It is true that the process for transforming naphthalene into phtalic acid, which was the only one known at the time when all these facts were first recognized, gave very bad yields, and was at the same time costly. The whole indigo problem stood thus reduced to the problem of transforming naphthalene cheaply and economically into phtalic acid. This has been accomplished by the Badische Anilin und Soda-Fabrik by heating naphthalene with fuming sulphuric acid in the presence of mercury salts. Torrents of sulphur dioxide escape, and the whole process can only be carried out properly if the means be given to convert this gas again into fuming sulphuric acid, which may be used again for treating fresh quantities of the hydrocarbon. The new sulphuric acid process of the Badische Anilin und Soda-Fabrik has thus been of paramount importance for the working out of the indigo problem.

Some of the older synthetical methods of producing indigo are so easy and rapid that they can easily be shown as a lecture experiment. If, for instance, we add a caustic potash solution to a solution of ortho-nitrobenzoic aldehyde in acetone, indigo is formed at once and settles out in dark blue crystalline flakes (Exp. IX.). The synthesis now in practical use is a little more delicate in its execution, but there are certain modifications of it which are rapid enough to be shown in a lecture experiment (Exp. X.).

The action of the alkali on the phenylglycine-carbonic acid does not at once produce indigo; a colorless derivative of the dye, indoxylcarbonic acid, or rather its potash salt, is formed at first, but if we dissolve this in hot water and introduce a current of air, it is at once and with a quantitative yield transformed into indigo which settles out in the shape of a crystalline deposit of infinitely fine division. This is collected in filter presses and delivered into commerce in the shape of a paste or a powder.

The industrial synthesis of indigo is extremely interesting, because it is a triumph not wholly due to chemical science. Science has shown the way to success, but it was quite unable to clear away the difficulties arising from practical and economic considerations. Here the representatives of our great industry had to advance independently and on paths for which theoretical knowledge could not serve them as a guide. Unlimited praise and admiration are certainly due to them for the masterly way in which they grappled with colossal difficulties and for the courage with which they staked millions on the realization of one great idea.

At the same time we cannot help feeling some regret for the indigo planters in the far East, who, after enjoying more than a century of easy prosperity, see now that more serious times are in store for them. They see the day coming when the indigo plantations will disappear, in the same way in which the madder fields of Avignon have vanished. But we are consoled by the knowledge that, especially for India, the time has already come, which has been so vividly described by Sir William Crookes, in one of his addresses to the British Association, as the future in store, sooner or later, for all humanity, the time when bread begins to be scarce. It seems to me that any one who, by bringing about some great commercial revolution such as we have seen in the indigo trade, causes land in India to become free for the growing of rice and other cereals, renders a great service to large numbers of poor natives, and need therefore not be blamed for lessening to some extent the prosperity of a class of people who have had an unusually good opportunity of accumulating wealth in the past.

It is a strange fact, that with indigo the history of the fight of the madder root against artificial alizarine is almost literally repeated in spite of the great difference of original conditions in the two cases. Madder was a product containing at its best only 4 per cent of actual coloring matter; the rest was useless fiber and obnoxious impurities which greatly hampered the dyer in his work. Alizarine, entering into competition with this natural product, was, on the contrary, the coloring matter in a pure state, and therefore not only cheaper but also much easier in its application. Indigo, such as we received it from India and Java, is a manufactured article, the best qualities of which contain 59, 60, or even 70 per cent of pure dye stuff, besides impurities which have always been considered as perfectly harmless. Thus the artificial product did not seem to have much scope for improvement as far as the quality came into consideration. Here again we have committed a mistake. We know now that the impurities are not harmless, and that the blues dyed with artificial indigo are quite as superior in brightness and purity of shade to those obtained with natural indigo, as alizarine reds were to madder reds. This has, however, not always proved to be an advantage for the manufacturers of artificial indigo. The world does not ask for bright indigo shades, and a good many prejudices in that respect had to be overcome before artificial indigo was admitted as a legitimate substitute for the natural product in some of its most important applications. Yet a simple consideration will show that it is always easy to deteriorate the brilliancy of a dyed shade, whereas no art of the dyer will suffice to produce brilliant shades on textile fabrics with dye stuffs that carry their share of dirty admixtures within them.

In its application to the fiber, indigo is perhaps the most remarkable of all dye stuffs, for it is the principal representative of that extraordinary class of coloring matters which must be applied by the vat process. This process, which consists in first reducing the dye stuff into a leuco-compound before applying it to the fiber, on which the original coloring matter is formed again by the action of the oxygen of the air, seems to have nothing in common with the ordinary dyeing processes. If, however, we consider it more closely, we come to the conclusion that vat colors are a class of dye stuffs in which the functions of dyeing and of selective absorption of light are distributed on two different forms of the substance, one of which contains two atoms of hydrogen more in its molecule than the other.

This theory is supported to some extent by the fact that, what we are pleased to call leuco compounds, are in the majority of cases by no means colorless. Indigo white itself is not white but yellow in its alkaline solution which we call a vat. Other vat dyes have leuco compounds which are even more strongly colored. Thus the leuco compound of indanthrene, a beautiful new coloring matter, is blue like indanthrene itself; flavanthrene, a yellow dye stuff, which has not yet left the laboratory of its inventor, has a blue leuco compound. One may say that with all vat colors the real dye stuff is the leuco compound which is afterward, when once fixed on the fiber, transformed into a pigment by the oxidizing influence of the air.

In 1825 Faraday discovered, in this very house, benzene; the original specimen, prepared by his own hands, is before you. We look upon it reverently, like on a sacred relic bequeathed to us by a master mind. But what a development has sprung from this first attempt to unravel the mysteries of the aromatic series! Our science as well as our industry have been revolutionized by the investigation of the derivatives of benzene, and the world has been embellished by the

gay and brilliant dyes of which it is the mother-substance. The study of the chemistry of these dye stuffs has become a domain of science which, for variety and fascination, can hardly be surpassed by any other. The deeper we penetrate into it the more it proves an inexhaustible mine of the most subtle scientific thought, yet one which never loses touch with practical life; it is interesting alike to the philosophical mind that wishes to revel in the wonderful perfection and order of nature, and to the philanthropic spirit which rejoices in seeing many thousands of hands occupied and princely fortunes produced by the utilization of what was only a short time ago a refuse and an encumbrance. It teaches a lesson even to those who are not attached to science and apt to consider it as a kind of pastime for people who lack ability for practical life. For they cannot help seeing that, in this case, the most intricate science has led to something eminently practical, commensurate to a standard which, though unknown to the Bureau International des Poids et Mesures, is to some people the only reliable one, viz., the one of £ s. d.

I am afraid that the high praise which I feel justified in bestowing on what has been the favorite pursuit of my life is not fully substantiated by the contents of this lecture. The subject which I had to treat is so vast, that all I have been able to say is nothing but a sketch or a programme of what would require a long series of lectures if full justice were to be done to it. My one excuse for attempting to sketch, in the short space of one hour, so vast a subject, is the place in which I had the honor to speak. An audience that has been addressed more than once by the pioneers of the chemistry of dye stuffs, by Faraday, Hofmann, William Perkin, and others, could, from one of the Epigones, not have looked for more than a few notes and additions.

THE SIGRISTE PHOTOGRAPHIC APPARATUS.

THE sensitiveness of gelatino-bromide of silver emulsions has necessitated the use of shutters that permit of leaving the objectives open for but a fraction of a second. The question has been studied in all its phases for the last fifteen years, and a conclusion has now been about reached, from a theoretical as well as a mechanical standpoint, as to what may be expected from shutters mounted near the objective or near the plate.

When apparatus such as objectives, shutters, etc., are

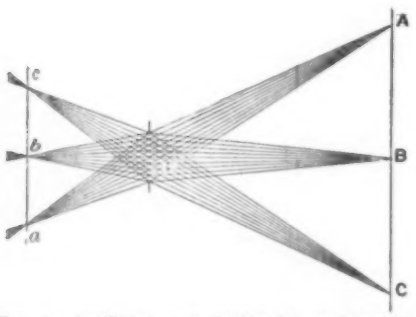


FIG. 1.—COURSE OF RAYS IN A PHOTOGRAPHIC APPARATUS.

represented in elementary treatises upon photography, it is generally the custom to figure the course of the luminous rays that traverse them by two lines that intersect each other in the center of the objective. The result is that we readily imagine that the rays collectively form the two cones of which the apices touch one another in the center of the diaphragm. In reality such is not the case. From every point of the object *ABC* (Fig. 1) there emanates a pencil of rays that form a cone, and all these elementary cones having their apices situated at different points, have their common base at the diaphragm. As for the pencil that emerges from the objective in the interior of the camera, that is formed of a similar system in opposite direction of which all the apices are at different points of the image *ABC*.

Upon considering this diagram we immediately see that a shutter mounted upon the objective cannot intersect all the pencils at once at a given point. There will always be a period of closing and a period of opening that will require an appreciable length of time. In practice these periods have finally been rendered very

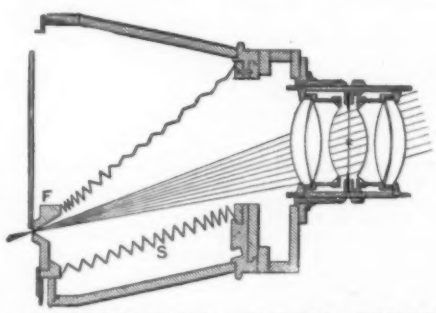


FIG. 2.—DIAGRAMMATIC SECTION, SHOWING THE MODE OF OPERATION OF THE SIGRISTE SHUTTER.

short, and an interval of varying length left between them representing the time of effective exposure, that during which the objective is operating under the best conditions. Whatever may be done it is impossible to reduce these various periods beyond certain limits and that is why our most improved objective shutters cannot give us satisfaction for great speeds—when, for example, it is a question of obtaining a sharp image of an object passing sidewise and at a short distance. It is true that the case is rather rare, and that the shutters of the most widely used apparatus are sufficient for current practice. Our objection to them would rather be that they work too quickly, for it is better to operate in the shade than in the sun. But the ideal is certainly to have an instrument that permits of obtaining the two extremes, and such a result can be reached only with a shutter that passes over the plate. Such shutters generally consist of an opaque curtain provided with a slit that displaces itself along the plate. In this case all the light acts under the best conditions; but it is easy to see (Fig. 1) that the efficiency will not be maximum unless the elementary cones are intersected at their apex. Provided that they present an appreciable extent at the place where the section is made, the obturation is no longer instantaneous, and this is a matter of great importance not only from the viewpoint of sharpness, but also in a general way, from that of the quality of the image.

Mr. Guido Sigriste, a painter of talent as well as a skillful mechanic and good mathematician, thoroughly

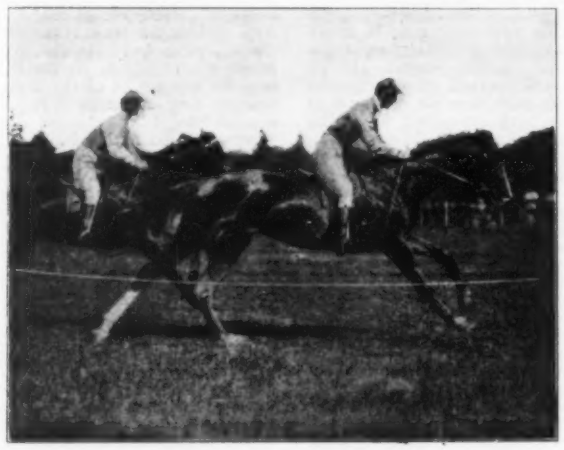


FIG. 3.—RACE HORSES PHOTOGRAPHED AT 5 METERS FROM THE APPARATUS.

realized the exigencies of shutters of this kind when he had recourse to photography for the study of horses running at high speeds After several years spent in tentatives and researches, he has succeeded in constructing an apparatus of maximum efficiency, which is a true instrument of precision. In fact, he has succeeded in making the slit through which the light passes, slide at 1-10 millimeter from the plate.

This slit, *F*, is formed of two strips of wood beveled at the edge and secured to the side carrying the objective through a skin bellows that follows it in its motions. (Fig. 2.)

The luminous pencils forming the image are, upon emerging from the objective, always comprised in this envelope; but their apices can reach the plate, through the slit, only successively, to the exclusion of any foreign light that might prove inimical to the formation of the image. This arrangement permits the light to act under the best conditions, even in the least favorable cases in which, as has been supposed here (Fig. 2), the objective admits very oblique pencils. As the edges of the slit have the beveled part turned toward the interior of the bellows, they arrest none of the elementary rays.

It is clear that this slit may be made more or less wide, at the will of the operator, who can vary it without opening the apparatus, and that its velocity can be regulated at will, as we shall show by a detailed examination.

The aspect is that of an ordinary twin camera (Fig. 4, Nos. 1 and 3). The finder consists of a frame *M*, an eyehole, *H*, and a sight, *E*, so arranged that the centering is always exact from a given distance. The shutter *F* (Fig. 2), is mounted upon a frame fixed to the extremity of the bellows, *S*, and sliding upon the back of the camera in such a way as to traverse the entire plate. The distance apart of the strips that form the slit may be varied by actuating a screw, *V* (No. 5), the square head of which engages in a cavity *D* that may be maneuvered from the exterior by means of a winch. A movable plate automatically closes the slit after the shutter has operated, so that the latter may be set anew without uncovering the sensitized plate. In order to change the plate and set the shutter, it suffices to actuate the magazine, *P* (No. 2), like an ordinary drawer. When pulled out it carries along a piece, *F*, to which is attached the extremities of a cord wound under the pulley seen at the lower part of the camera (No. 2), and that corresponds to the spring inclosed in the barrel, *B* (Nos. 5 and 6). When the drawer is at the end of its travel it is shoved back; but a tappet, *T*, retains the shutter, which remains in place.

Two buttons placed at the side of the apparatus, and capable of operating independently of one another, permit of disengaging the tappet, *T*. The slit then begins to move under the action of the spring, and, in order that it may keep up a uniform motion during its entire travel, two compensating springs, *R*, placed on each side offer an increasing resistance at the beginning, then straighten out, and finally aid in the motion. Experience has shown that perfect regularity is obtained in this way.

The velocity of displacement of the slit naturally depends upon the tension of the spring in the barrel, *B*, and this is determined by the maneuvering of a lever, *L*, (Nos. 4 and 6) that traverses the dial that may be seen in one of the sides of the apparatus (No. 5). The winch for the regulation of the slit is placed upon the side of the dial, and, at every revolution, causes the advance of an index that marks the width of the slit in half-millimeters.

The graduation that the operator has under his eyes is a function of the two important elements to be known, viz., the velocity of the displacement and the width of the slit. Both can be changed in an instant, and a glance at once shows under what condition the shutter is going to operate. To this intent it suffices to read the number inscribed upon the dial (No. 4) in the section occupied by the lever, *L*, and opposite the figure indicating upon the latter the width of the slit. The figures given here have been verified in a very precise manner by means of the D'Arsonval electric chronograph. The objective used may be of any make whatever. If it is desired to obtain photographs of race horses for which the time of exposure is 1-2800 of a sec-

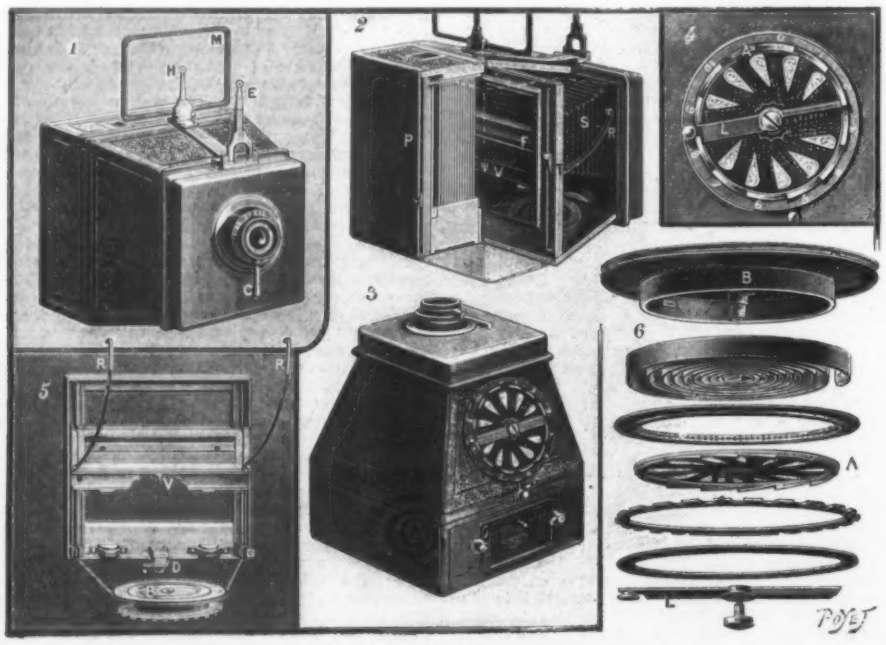


FIG. 4.—SIGRISTE PHOTOGRAPHIC APPARATUS.

No. 1.—General view of the camera and finder. No. 2.—Details of the magazine and shutter slit. Nos. 3 and 4.—View of the apparatus and the dial indicating the velocity. No. 5.—Details of the shutter.

ond, objectives of a wide aperture should be employed. —Specially translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

THE STEAM TURBINE—ITS COMMERCIAL ASPECT.*

By EDWARD H. SNIFFIN.

THE steam turbine is not as young as it looks. Although its application to commercial power generation in its present several forms is the achievement of recent years, its principle is neither new nor novel, and it may be wondered that a century of effort should have been applied to the reciprocating engine—which became, indeed, more complicated as it grew—before the primal theories of the heat motor assumed corporate, practical form. It is true that later knowledge of materials, and how to work them, has made the way clearer, and the wider use of the steam turbine has in a measure depended upon the development of electrical practice, with which latter it is now so intimately identified.

Much interest has for some time been centered in this type of prime mover and the possibilities of its application. The history of its development is quite generally known, and up to this time attention has been more particularly directed to its engineering and mechanical characteristics. It now seems appropriate to inquire into the controlling features of its commercial utility, and determine, if we may, whether the steam turbine, subjected to a somewhat careful analysis, is a machine still to be developed, though of ultimate promise, or whether it has been well tried and its advantages proved. What has it accomplished? What justifies its use? What otherwise unattainable results will it produce? What are its limitations? It is this aspect of the case on which the light is needed.

It is of little moment what the direct or contingent advantages of the turbine may be, if its reliability remain in doubt. Offered, as it is, in large units, and being apparently more related to the classes of service which impose the most exacting requirements, the demand is imperative that in this one vital respect there be little left to chance.

In this country the steam turbine is now operating in several plants. The first prominent installation was at the Westinghouse Air Brake Company's Works, at Wilmerding, Pa., where the first unit was started in August, 1899, two more shortly after, and the fourth unit in April, 1901. Thus the plant has been in service, for the most part, more than three years, and the fourth unit about eighteen months. The plant operates regularly eleven hours a day, the service being electric power and lighting. With the iron foundry running at night, one turbine is run twenty-two to twenty-three hours per day. In general, the units have run quite to their rated capacity—perhaps within 20 per cent of it—as a minimum. An interesting comparison has been made elsewhere of the efficiency of this turbine plant with the installation it supplanted, the latter comprising simple and compound engines, scattered about the works. After the three turbine units had been placed in operation they were shut down, and the steam engines previously in use (not yet disconnected from service) were again started up and a test made. A test was then made of the turbine plant. These were based upon a week's run, careful measurements being taken of fuel and water. The saving of coal in favor of the turbine plant averaged 35.7 per cent during the day, and 36.4 per cent during the night. The saving in feed-water averaged 29.8 per cent during the day and 41.4 per cent during the night. In round numbers this meant a saving of about 40,000 pounds of coal per twenty-four hours. This improvement, of course, was attributable not entirely to the turbine itself, but also to the more efficient method of electric power transmission in comparison with the previous scattered arrangement of steam engines, with long runs of steam piping, use of belts, etc. It is, however, instructive as indicating the results accomplished in a specific and prominent case, as between an old and still commonly used system of power transmission and a modern method.

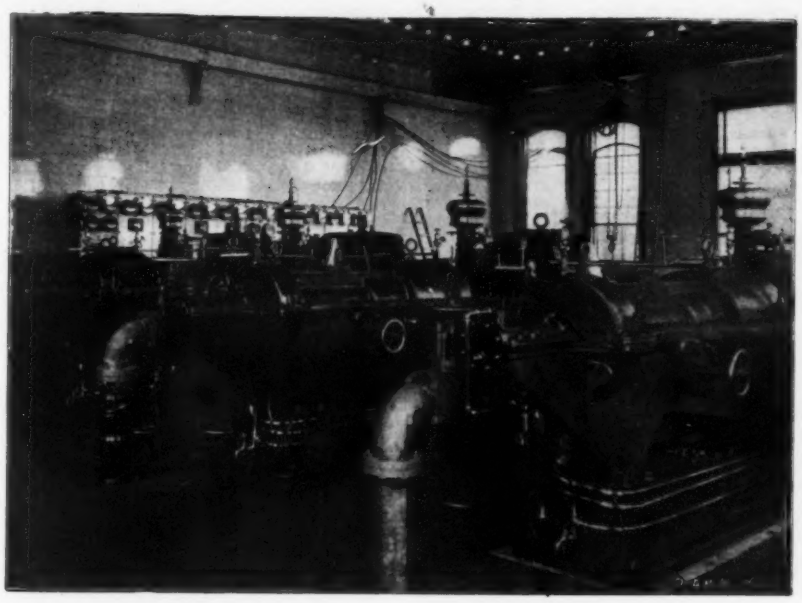


FIG. 1.—TURBINE PLANT AT THE WESTINGHOUSE AIR-BRAKE WORKS, WILMERDING, PA.

FIG. 2.—1,500-K. W. WESTINGHOUSE-PARSONS TURBINE AND ALTERNATOR.

This plant at Wilmerding was the first of its kind. It naturally was not without its minor difficulties. The turbines themselves, from the time of starting, have been practically free from trouble of any kind. Some armature difficulties were at first experienced, but not of enough moment to interfere with operation, and were readily corrected. Summing up the experience had with this first installation, undertaken somewhat experimentally at the time, the net result is that the plant has operated about three years in heavy daily service; that the work has not suffered interruption, and that the plant is to-day running with sustained satisfaction and with no visible signs of wear in any of its parts. Fig. 1 shows this installation, comprising four 400 kilowatt units located within a space 45 feet by 61 feet, the height of the engine room being 20 feet 6 inches.

The Yale & Towne Manufacturing Company, at Stamford, Conn., has a 400 kilowatt steam turbine furnishing 240-volt, two-phase current at 7,200 alternations. This outfit was started in operation February 1, 1902. Since that time it has been in regular daily service, carrying about its rated load, operating ten hours per day, furnishing current for electric motors and some lighting. Up to this time, therefore, it has been in service about eight months, and its mechanical operation has been most satisfactory. No quantitative tests have yet been made of steam performance, but there is general evidence of its economical operation.

The Hartford Electric Light Company, at Hartford, Conn., have a 1500-kilowatt, two-phase, 2400-volt, 60-cycle, turbo-generator outfit, which was started in April, 1901. This, at present, is the largest turbine yet installed in this country. Put in, as it was, to relay their water power, it has not been in constant service, but has usually been required only one or two days a week. At such times, however, it has carried the full station load of some 1800 kilowatts or 1900 kilowatts. Reference will hereafter be made to its striking economy.

A great deal of interest has centered in this early installation of a good sized outfit in a prominent location, and its excellent performance is now generally well known. Some difficulties were at first experienced; nor were they entirely unexpected, for there had been no facilities, as there are now, for testing the outfit before shipment, and it was merely run at the shop without load. Before the machine was successfully in operation one trouble that developed was with lubrication. The packing glands around the turbine shaft leaked somewhat, and the construction of the oil passages with reference to these glands, enabled the oil to come into contact with the steam, impairing its lubricating quality. This was easily overcome by modifying the vents and employing glands of different construction.

Some time was also required after erection to make necessary adjustments to relieve the turbine of longitudinal end thrust. This would have been corrected at the shop had the opportunity then been present for making complete test. It was found, too, that the shaft, which had been designed to afford the utmost ease of dismantling, was subjected to a considerable unevenness of temperature under superheated steam, and means were taken to make the temperature at all points more uniform. Having in due time overcome these local defects, which partook in no sense of functional fault, the turbine was then in serviceable con-

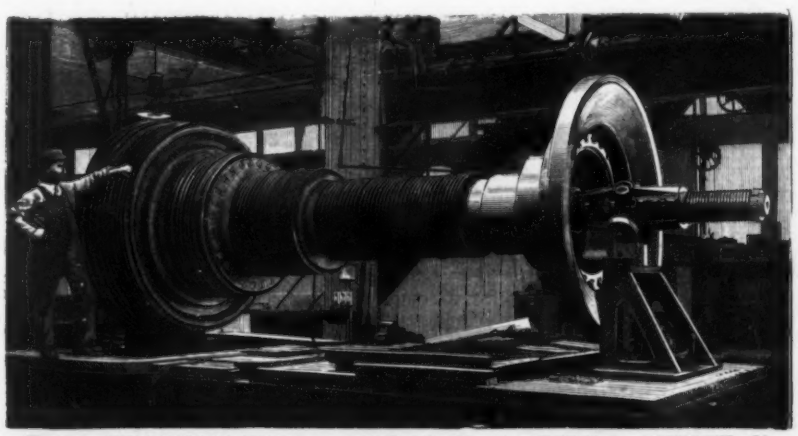


FIG. 3.—REVOLVING PART OF THE 1,500-K. W. TURBINE. LENGTH, 20 FEET. WEIGHT, 14 TONS.

* Paper read at the Detroit Convention of the American Street Railway Association.

dition, and its operation has since been most satisfactory. The Hartford Company, notably alert to adopt the newer thing if there seemed advantage in it, found when their water supply ran short that it paid to run the turbine and allow their Corliss engines to remain idle. This turbine is seen in Figs. 2 and 3.

Is the steam turbine efficient? And what, if it may be so termed, is the character of its efficiency? Is it, like the various types of piston engines, peculiarly fitted to certain conditions which permit of little change if economical performance be retained, or is there evidence that the turbine has a greater inherent efficiency that is less affected by attending circumstances?

The interest of engineers in the turbine has, perhaps, been drawn chiefly to the evident possibilities of its steam economy, and to the data already acquired, with the discussion it has provoked, much more of value will be added. We may in a general way, however, without referring to its thermodynamics obtain from the evidence of actual results some knowledge of its efficiency and determine if the standards of present practice may not be improved.

It is well that the makers of the turbo-generator have been compelled to adopt the practice of basing the steam consumption on the unit of output, so that their guarantees are given on the electrical horse-power or kilowatts delivered on the switchboard, and not on the indicated horse-power developed. This at once eliminates the factors of engine friction and generator loss, and thus more definitely establishes a measure of performance.

One is impressed with two distinguishing features of the turbine's steam efficiency, namely, that it seems to vary but little over wide ranges of load, and, further, that the size of the unit has comparatively little bearing. It follows, then, that if good results are possible at all, they are neither restricted to the larger plants nor to the requirement of steady load.

Fig. 5 illustrates this. Herein are given the results of tests on a 400-kilowatt turbine made at the builders' works before shipment, the machine having since been in daily operation eight months. These tests were conducted under brake load, so that the figures are based on the brake horse-power developed. The rated load would be about 600 B. H. P. The steam consumption is seen to be very flat, graduating from 14.47 pounds at full load to 16 pounds at half rating, and to less than 19 pounds at one-quarter capacity. The relation of the consumption of steam in pounds per hour to the brake horse power developed is also shown, this line being almost straight. In the tabulation may be observed the interesting comparative effect of vacuum and superheat.

If it is thus shown that with a unit as small at 400 kilowatts we may obtain a result of 14.47 pounds of steam per brake horse power per hour, corresponding to less than 13¾ pounds per I. H. P., it is evident that moderate sized plants may with the turbine be sufficiently subdivided to give the maximum flexibility of service, with insurance of relay, and yet possess an efficiency heretofore identified only with very large units. Further than this, a fluctuating load is not incompatible with high economical performance.

As the units become larger the turbine is then brought into comparison with the best steam-engine practice, where it still preserves its uniform efficiency, and where its practical advantages are no less evident. In a recent instance, a result of 11.7 pounds of steam per electrical horse power per hour was guaranteed on a turbine of 750-kilowatt capacity, corresponding to about 10.17 pounds per I. H. P., which, though the size is moderate, is perhaps within the ability of but few engines of any size or type that have ever been built.

It may be pertinent to cite a few results obtained in regular service. The turbine at Hartford, under test conducted by Prof. Robb, at an average load of 1800 kilowatts, with 155 pounds steam pressure, 27 inches vacuum and 45 degrees superheat, gave a result of 19.1 pounds of steam per kilowatt hour, or an equivalent of about 11.46 pounds per I. H. P. hour. An interesting comparison has been made at this plant of the relative efficiency under regular operating conditions of the turbine and their Corliss engines. They have one 18-inch and 34-inch x 48-inch and one 24-inch and 44-inch x 60-inch cross-compound horizontal Corliss engine. These engines drive direct by belt one 400-kilowatt and one 600-kilowatt generator. The turbine is, of course, direct-connected to its generator. They have made comparisons of operation based in each case on rather extended runs. It has been found that the turbine requires in delivering 1,900 kilowatts on the board about the same amount of coal that is used with the Corliss engines to deliver 925 kilowatts, the steam pressure

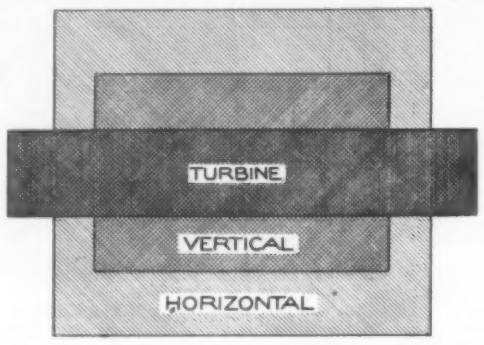


FIG. 4.—COMPARISON OF FLOOR SPACE OCCUPIED BY HORIZONTAL, VERTICAL, AND TURBINE ENGINES.

and vacuum being identical in both cases, and this with the engines running at about their point of best efficiency and known to be in excellent condition. Comparisons of this kind, while not scientifically exact, are, perhaps, of greater interest as a measure of commercial performance.

The data at hand of test on one of the 400-kilowatt turbines at Wilmerding shows a result of 16.4 pounds per E. H. P. hour at full load, with 125 pounds steam pressure and 26-inch to 27-inch vacuum. At half load it is 18.2 pounds.

At the Elberfeld Municipal Electricity Supply Works, in Germany, two 1,500 H. P. Parsons turbines, which are run in parallel with two Sulzer horizontal engines, were tested by Prof. Schrotar, Dr. Weber and Mr. Lindley. With steam pressure averaging 95 pounds, running condensing, and with 18.3 degrees of superheat, the result obtained at maximum load was 19 pounds per kilowatt hour, or about 11.4 pounds per I. H. P. hour.

Many other results have been recorded, but those given will probably be sufficient to show that under service conditions the turbine has demonstrated its high efficiency.

But is its efficiency maintained? A question often asked, and a very important one, too. Looking at the turbine casually, it seems as though there would be little opportunity for any change in its mechanical functions. There is no complicated valve gear to get out of adjustment; no pistons to leak; no rubbing surfaces to set up excessive friction; little chance of misalignment, and altogether there seems to be no good reason why its original condition should ever be very much disturbed. The blades appear to be the vulnerable point, for they do the work, and there are a good many of them. Their number, though, is in their favor, and, being loaded as they are to only about 2½ per cent of the pressure they are built for, they possess an abnormally large factor of safety. The experience has been that the turbine is less liable to depart from its original standard of performance than any other type of prime mover, and there seems little reason to suppose that it is capable of much deterioration.

A recent interesting investigation along this line was made at the plant of the Cambridge Electric Supply Company, Ltd., in England, where they have a 500-kilowatt Parsons turbine. The outfit was erected in January, 1900, and during the past year has been doing constant work. After it had operated about eight months a second one was installed. The first outfit had been tested at the maker's works before shipment, and showed a result of 24.1 pounds of steam per kilowatt hour at 526.4 kilowatts. And it was for the purpose of noting its performance after a year's operation that Prof. Ewing conducted a second test.* In this latter test the turbine at 518 kilowatts, under nearly equal conditions of steam pressure and vacuum, gave a result of 25.0 pounds, and at 586 kilowatts, 24.4 pounds. In the second instance, the turbine, besides trouble experienced with wet steam, was driving its own air and circulating pump (a surface condenser being used), and the steam required to drive these auxiliaries was charged to it. In the test at the builders' works the turbine did not drive its pumps. The results, to use Prof. Ewing's words, give most satisfactory evidence that the turbine retains its character as a highly efficient generator.

It remains to be said in this general connection that there will be found in steam-turbine practice a more satisfactory treatment of the economy question than has heretofore prevailed. There will exist not only a truer basis of measurement than the indicated horse-power, but there will be opportunity for more thorough demonstration. It is now generally recognized that efficiency guarantees on large engines have little significance. The builder is physically unable to completely assemble and test such engines before shipment, and the user is seldom able or disposed to incur the distraction and expense which a field test involves. It is in the exceptional case, therefore, that actual tests are made, and there is still much to be known concerning the economy performance of large engines. It might be said, too, that while builders and engineers generally recognize the elements of design that conduce to efficiency, there is no unanimity of opinion as to what those elements will actually produce.

It is, therefore, gratifying to know that one builder, the Westinghouse Company, is now erecting a new testing room in which a complete plant of boilers, condensing and superheating apparatus will afford facilities for testing turbines up to 3000 H. P. at-all loads up to full capacity, and larger units up to this point, with practically any steam pressure and wide ranges of

* London Engineering, June 14, 1901.

TEST OF WESTINGHOUSE-PARSONS STEAM TURBINE

NO. OF TEST	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
BOILER PRESSURE	148	147	147	132	149	149	148	149	148.5	150	155	148	148.5	153	150	150	148	152
VACUUM REFERRED TO 30" BAROMETER	27.4	28.04	27.93	27.06	27.35	27.4	27.1	26.7	26.7	27.37	27.34	27.3	27.3	26.94	27.35	27.3	27.3	27.3
% MOISTURE IN THE STEAM	2.3	2.3	2.35	1.6														
SUPERHEAT DEGREES FAHR.					7	9	8	8	9	17	20	18	20	20	33	37	37	33
REVOLUTIONS PER MINUTE	3687	3621	3603	3613	3686	3635	3626	3637	3618	3688	3639	3625	3638	3630	3690	3630	3626	3642
TOTAL WATER	780.3	4354	5157.0	3227.0	722.7	4507.0	5587.0	7568.0	9192.0	687.0	4321.0	5435.0	7249.0	8789.0	6693	4180.0	5129.0	7185
BRAKE HORSE POWER	0	250.0	306.0	593.0	0	264.0	348.0	489.0	602.0	0	263.0	346.0	487.0	607.0	0	260.0	334.0	490
WATER RATE		17.4	16.9	15.5		17.05	16.05	15.45	15.28		16.43	15.7	14.85	14.47		16.13	15.35	14.67

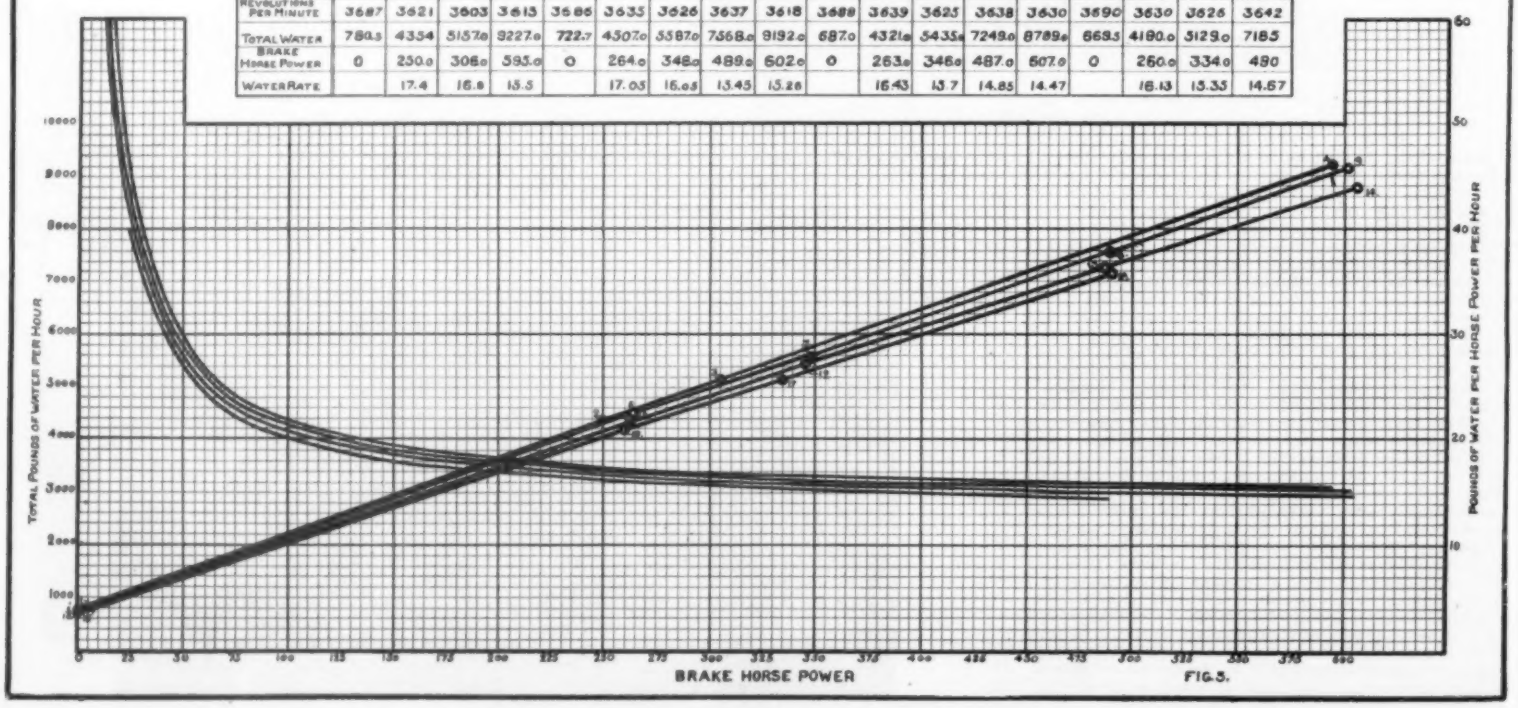


FIG. 5.—RESULTS OF TESTS ON 400-K. W. TURBINE.

vacuum and superheat. Thus, the conditions to be met in practice may be approximated in the shop, and the information acquired will be of the highest value.

Turning now to one notable feature of the turbine, its compactness, Fig. 4 is a graphic illustration of the floor space it occupies, compared with the vertical and horizontal cross-compound Corliss engines, the basis of comparison being a 1000-kilowatt unit, including the direct-connected generator, the engine cylinders being 28 inches and 56 inches x 48-inch stroke, which, at 95 revolutions, with 25 pounds mean effective pressure referred to low-pressure cylinder, gives about 1400 I. H. P. It will be seen that the floor area of the turbine is about two-thirds that of the vertical engine and about two-fifths of the horizontal. Such comparison, of course, is limited in its application. With each set of conditions requiring special treatment no standardization of space requirements can be established. Still, with the limitation of isolated experiences, it is possible, without attempting to establish any universal laws, to make some reasonably close comparisons of the space required for the turbine as against the conventional types of engines. It has been thought desirable, then, to take a number of different sized plants, each composed of several appropriate sized units, the selections being as follows:

1,000 H. P. in	2	400-kilowatt units.
3,000 H. P. in	3	750-kilowatt units.
5,000 H. P. in	4	1,000-kilowatt units.
*10,000 H. P. in	3	2,500-kilowatt units.
15,000 H. P. in	4	2,500-kilowatt units.
30,000 H. P. in	4	5,000-kilowatt units.
50,000 H. P. in	7	5,000-kilowatt units.
75,000 H. P. in	10	5,000-kilowatt units.

These combinations were laid out for the turbines and for the vertical and horizontal cross-compound Corliss engines, all with their direct-connected generators. A clearance space of 7 feet in all directions was allowed, and is probably a fair average. The computations were confined to the units themselves, with the clearance stated, the disposition of the balance of the plant being assumed to be unaffected by the type of motive power.

In a comparison, by a diagram, of floor space, the curves show the turbine to require about 80 per cent of the space needed for the vertical, and not over 40 per cent of that wanted for the horizontal. In this diagram the vertical engine compares less favorably with the turbine than might generally be supposed, while the horizontal engine curve is about where one would expect to find it.

In a comparison of the cubic yards of foundation material required, the turbine would appear more advantageously still, if the actual foundations needed for stability had been computed. Instead, the foundations in all three cases were figured at 15 feet depth to give space underneath the engine room floor for condensers, etc., though for large engines this depth is usually inadequate. The only foundation needed for the turbine is that necessary to hold its weight, as if it were a tank, or some other stationary affair. It does not even require foundation bolts, there being no vertical or horizontal thrusts to be resisted. Comparing again the 1000-kilowatt units, it is found that in actual foundation volume required the ratio of the turbine to the vertical and horizontal engine is that of 1 to 9 and 15, respectively.

In a comparison of engine-room building space, the turbine appears to hardly less advantage, though the horizontal engine, gaining in head-room what it lost in floor space, compares more favorably with the vertical.

Having noted, then, the marked advantage which the turbine appears to offer by virtue of its compactness, it would seem that the comparison might be carried a little farther, and with assumed valuations of masonry work and building construction, as well as of land, the money saving to be effected in these important features of initial cost be defined.

In a comparison of the comparative cost of foundations it is seen that while the turbine seems to average a foundation cost of about 50 cents per horse power, the vertical engine in the more frequent sizes is approximately $1.50, while the horizontal is not far from $2.50. Not forgetting that all three foundations are figured of equal depth—15 feet—to provide space below, as before stated. In the instances where special foundation work is required, such as piling or otherwise preparing suitable bottom, or shoring up building walls to enable sufficient depth of excavation, the expense avoided by the use of turbines is obvious.

In showing comparative engine-room building cost, the basis assumed is 15 cents per cubic foot of space inside of walls. Building construction necessarily varies widely with the size, design and materials employed, but the figure taken is perhaps not far from a fair average for building built of brick, with steel trusses and fireproof covering. The curves show that the building cost for the turbine is about one-half of what is required for the horizontal or vertical engine, the latter two apparently not being far apart. In this comparison of building cost experience would differ widely. Architectural considerations and local conditions would produce varying results. Exigencies would, however, favor the turbine, because of its smaller size and rectangular proportion, and it not infrequently happens that increased power may be supplied by locating the turbine in existing space, whereas an engine would necessitate building extension, and, perhaps, the purchase of additional land. An instance of this kind arose at Akron, Ohio, where in the existing space no arrangement could be devised to accommodate additional engine power. It was found possible, however, by rearranging auxiliary apparatus, to provide space for one 750-kilowatt and one 400-kilowatt turbo-generator outfit, which will shortly be in operation.

A diagram summarizing the preceding curves, and with foundations, building and land at the valuations given, shows how these factors of cost compare. The data will have served its purpose if it show that in a properly designed plant employing the steam turbine far more money may be saved in these particulars than is ever represented by the difference in cost between machinery of high grade and that of inferior quality.

A case or two may be to the point. A plant was recently laid out to contain three 1000-kilowatt units, with vertical cross-compound Corliss engines. Subsequently three more 1000-kilowatt units were contracted for, steam turbines being ordered. It was found that the turbine saved 900 square feet of engine-room floor space and about 38,000 cubic feet. Had the whole plant been originally designed for turbines the saving of space would have been double these amounts, and the cost of land, building and foundations been reduced about $50,000.

An electric railroad plant in Ohio was some time ago installed, in which there are 500-kilowatt generators direct-connected to cross-compound Corliss engines. Space was provided for two more units of the same size. For the increased power two 1000-kilowatt turbine outfits were purchased, which will go in the space left, and leave room for another turbine of 2000-kilowatt. Thus, the engine-room space planned for 2000-kilowatt is found sufficient for 5,000-kilowatt. It is estimated that the boiler plant extension will be reduced about one-third because of improved efficiency. It is figured, too, that a saving of $2,900 was effected on each 1000-kilowatt foundation.

One other case, of perhaps greater interest, recently came to notice, that of a plant of 8100-kilowatt capacity, laid out on modern lines, employing vertical cross-compound condensing engines. There is no space for additional engine power, and any increase would require building extension and encroachment upon valuable land. It was shown that without going beyond the present building walls, and without disturbing the existing machinery, the plant might be doubled in capacity by installing turbines in the space available below the present engine-room level and adding another deck of boilers. And it has been figured that this arrangement would effect a reduction of over $3 per kilowatt per annum in the present interest charge.

With some measure thus obtained of the comparative indirect expenses of installation we may turn to consider the cost of the turbo-generator outfit itself. Is it high in price, or is its cost, if not an attractive feature, still within our common idea of value? The answer is that its price is reasonable; that, indeed, where the comparison is fair, the turbine will require the lesser first investment. It is, unhappily, quite as difficult to compare the costs of the turbine and piston engine as to compare the costs of engines themselves. A thing is, of course, high or low in price by comparison, but where the steam engine is concerned, to measure values were a hopeless task so long as there are held divergent views of design and construction and of engineering adaptation, with the builders themselves wide apart in their practice.

There are engines of good workmanship and of poor, of heavy proportions and light, and generous and scant proportioning of cylinder size and ratio, and of piston speed, to the work to be done. Perhaps, too, the voice of experience may protest that the buyer's insistence on his bargain is not always in keeping with the quality he would have, or should have, and it is not surprising that commercial necessity should sometimes affect engineering ideals. While the reliable builder will adhere to his high standards, there still will be found those whose more flexible practice will suffer impairment of quality to fit the price.

Proceeding with the comparison, however, it may be assumed that the larger field for the turbine begins about where the high-speed engine leaves off. Its steam economy at once identifies it with the most efficient engine practice, and it therefore applies more appropriately to the classes of service where medium and large-size units are used. The comparison, then, lies, generally between the turbine and the slow-speed engine. It remains merely to take an engine and generator of good construction, bring the engine efficiency as nearly as possible into parity with that of the turbine, also having it possess the same overload capacity, to find that the turbine is reasonable in price. And when we add the possible saving in foundations, buildings, etc., the first cost of installation is usually much in its favor.

There remain still one or two important features of electric power plant operation wherein the use of the reciprocating engine is attended with difficulty, and with respect to which the steam turbine offers unquestioned improvement.

One of these, the running of direct-connected alternating current generators in parallel, has come to be a frequent requirement, but frequent as it is, and essential as it is, its accomplishment has been anything but an exact science. There has, in fact, been so little synchronism of method as to justify some wonder at the results that have really been obtained. There is no need here to particularize the complications of the problem. It obviously is not the work of the tyro to introduce into two or more units the identical conditions that will convert reciprocating motion into synchronous rotating motion, co-relating, as he must, the features of governing functions, inertia of reciprocating parts, fly-wheel weight and radius and the like. And it becomes evident that where successful parallel running is achieved it is the triumph of skill not only in design, but in the handling of the machinery itself.

These difficulties cease with the turbine. In it there is no fluctuation of angular velocity. There is but one direction of motion, with no element to detract from even turning moment, and due to its speed there is stored up more fly-wheel effect than is present in the piston engine.

It is, therefore, found that not only do steam turbines easily run together in parallel, as hydraulic turbines have always done, but it may be expected that they will operate with piston engines and the performance of the latter in this respect be much improved. In electric railroad work especially is this feature of the steam turbine of much interest, for it is well known how irregular loads accentuate the difficulties of regulation. Furthermore, the question of operating high-frequency apparatus in combination electric railroad and lighting service may be more satisfactorily approached.

The feature next in importance, perhaps, is that of superheated steam. It is now quite generally recognized that superheating is of advantage, though there is still much about it to be learned. Future investigation, however, in which the turbine will take important part, will reveal more precisely its economical status, and it may be hoped that before long the net advantages derivable from different high-steam temperatures will be known. Meanwhile, superheaters are being installed, and collaterally the problem of handling superheated steam has assumed importance. Engine builders themselves are feeling their way, for while some appear unrestrictedly to offer the Corliss valve for superheat work, others seem prone to confine it to the more conservative temperatures, and others still reject it altogether, and hold to the poppet valve, where superheat is employed.

The turbine may be used unreservedly with superheat of any feasible temperature. It has no internal rubbing surfaces, and there are no glands to become injured. Also, as no cylinder oil is required, there is no opportunity for lubricating trouble. Furthermore, there seems to be with the turbine rather more proportionate benefit from superheat than with the piston engine, because of diminished skin friction.

Having said that the turbine requires no cylinder lubrication, the inference follows that the steam is therefore uncontaminated with oil, and that the exhaust, when condensed, is pure distilled water. This is true, and while it is of little consequence where water supply is abundant and good and cheap, it becomes, where conditions are otherwise, of exceeding importance. In many sections of the country, where the water contains either mud or scale-making impurities, the cost of repairs to boilers, with the expense in labor and interruptions of service entailed by constant cleaning, is a besetting evil, and to alleviate this trouble large surplus boiler plants are often installed. As a usual thing, too, difficulty is experienced in attempting to extract oil from exhaust steam.

To recur once more to this feature of lubrication in the turbine, it may be remarked that it is an item of very little expense. The bearings are the only points requiring oil, the lubricant being circulated around under pressure. The reservoir being once charged, very little is needed to maintain the supply.

Finally, in this commercial consideration of the turbine, one other question should perhaps not be omitted, one, in fact, which sometimes seems to outweigh almost every other, namely: How long does it take to get it? While the demand has, in truth, for some time exceeded the capacity for production (there being now under construction at East Pittsburg some 44,000 kilowatts on order), so that the turbine has required about as much time to build as everything else, the extended facilities now nearing completion will better this considerably. Certainly, under normal conditions, these outfits, made of comparatively small parts, with no enormous pieces to be handled, ought to be quickly built, and what is quite evident, they can, when delivered in assembled condition, be so readily installed that the months sometimes required to erect large engines will be reduced to weeks.

If it is, then, seen that the steam turbine in all the essential aspects of its commercial utility appears to stand on solid ground, there cannot be yet attributed to it the virtue of universal application. It has its field chiefly in electric lighting and power work, though in small sizes it has been extensively used for driving blowers, pumps and other devices. Its speed, of course, prohibits belt drive.

But the direct-connected electrical generating unit has been the *sine qua non* of modern power development, and the reciprocating steam engine, under the stimulus of opportunity, has been brought nearly to its mechanical and thermal limit. With all the ingenuity and skill and patient effort that have marked its growth; with its notable achievement, symbolizing as it does the march of industrial progress, it still remains, even in its most advanced form, a wasteful and complicated means for converting heat into energy. If we are to exact further tribute from the agency of steam; if we would hope to reduce complexity, and by a more simple, reliable and durable method of operation reduce the interest and maintenance charge; if, in a word, we would improve the standard of existing practice and surmount many of its limitations, we must then change the character of our medium, employ different principles and give to the generation of power a new and greater significance. The steam turbine seems destined to mark the way.

* In this size the horizontal engine is figured on 3re 1500-kilowatt units.

MAKING EGGS TELL THEIR AGES.

ACCORDING to the Bäcker und Konditor Zeitung the age of an egg is now discovered by immersing it in a solution of salt containing about eight ounces to the pint. When the salt has thoroughly dissolved, the egg to be tested is dropped gently into the glass containing the solution. If the egg is only one day old it sinks immediately to the bottom; if three days old it sinks just below the surface only, and from five days and upward it floats.

Another process has just been awarded a medal in Saxony by the National Society of Poultry Breeders and is described in a German contemporary. It is well known that the air cavity at the blunt end of the egg enlarges as the age of the egg increases. Consequently, if the egg be placed in a solution similar to the one described above it will have an increasing tendency to float with the long axis vertical. A scale of angles is placed at the back of the vessel, and from the inclination of the egg to the horizontal the age can be gauged almost to a day. A new-laid egg lies horizontally at the bottom of the vessel. When three to five days' old the egg raises itself from the horizontal, so that its long axis makes an angle of about 20 degrees with the horizontal. At eight days this angle increases to about 45 degrees; at fourteen days it is 60 degrees; at about three weeks it is about 75 degrees, while after four weeks it stands upright on the pointed end.

Glycerophosphates.—A note regarding the preparation of the so-called glycerophosphates appeared in the Circular for February, page 39. As we there remarked, we find no mention of them in standard works on materia medica which we have consulted, including a quite recent one; from which it may be inferred that they have not received much attention from the medical profession.

Sirups and perhaps solutions of them have been made. The strength would be a matter for the prescriber to regulate.—Drug. Cir. and Chem. Gaz.

THE LIFE OF A XIPHOPAGIS, OR "SIAMESE TWINS."

THE study of the anomalies of the human organism is of value not only from a biological, but from a psychological standpoint, especially when it touches upon the domain of teratology, which is so very interesting for scientific researches. Along about 1836 Isidore Geoffroy Sainte-Hilaire, in his celebrated work entitled "General and Particular History of the Anomalies of the Organism in Man and the Animals, etc., or Treatise upon Teratology," gave a complete account of the character, classification, physiological and pathological influence, general relations, causes of and laws governing monstrosities. This is the most exhaustive treatise that has appeared upon the subject, and all other authors have drawn largely upon it on the occasion of every new study of a monstrosity. The book contains some remarkable and curious observations.

The xiphopagis constitute a teratological group which is very curious, especially because of the parallel, and, so to speak, individual existence of two biological organisms and, at the same time, of two mental lives. Apropos of this, says Dr. Vaschide, in La Nature, I have, along with my two collaborators, MM. Pieron and Vurpas, had an opportunity of studying a living xiphopagis of the masculine sex which the Barnum & Bailey Circus exhibited at Paris last winter.

The xiphopagis in question belonged to the type that teratologists designate as monomphalians, which means consisting of two individuals united by the lower extremity of the sternum and having but a single umbilicus. Their name is derived from the Greek designation of the xiphoid cartilage (ξιφοῦς), and the word παγεις meaning "united," and refers to the fact that the two subjects are united by their xiphoid or ensiform cartilage. The celebrated Siamese twins were one of the most famous examples. The xiphopagis in question is fifteen years of age and of Chinese origin. Dr. Chapot-Prevost, a Brazilian surgeon who successfully separated a xiphopagis of the female sex, the case of which is well known (see SCIENTIFIC AMERICAN SUPPLEMENT, No. 1284) made a clinical and rapid examination of the physiognomy of the subjects, like the other subject, right-handed. Liao-Sienne-Chen possesses a greater sensitiveness of touch, heat, and pain, while his circulatory and respiratory functions are more robust. The motive coördination is perfect, and, when acting in conjunction, according to a previous understanding, the two are capable of executing extremely supple motions. The membranous band that unites them, the vertical diameter of which measures 8.5 cm. (3.34 inches), is very elastic. Its circumference, which, in the normal state, is 21.5 cm. (8.46 inches), is capable of diminishing and increasing about 1 cm. (.39 inch) under the influence of respiration, and especially of a muscular effort. The distance between the two subjects is, on an average, 6 cm. (2.36 inches), but sensibly increases and sometimes reaches 14 cm. (5.51 inches) when the subjects are walking about. The subject on the right almost always takes the lead of his companion. In order to walk, they put themselves nearly in the same plane and move slightly to one side.

From a physiological point of view, it should be remarked that general sensations such as hunger, thirst and the various needs of nature manifest themselves almost involuntarily. Habitude counts for much therewith, their biological life being so intimately connected, the mental representations that accompany such sensations have necessarily undergone the same rhythm in their automatic evolution.

A tactile sensorial examination of the connecting membrane reveals some very curious psychological phenomena. There is a median zone, insensible to touch, on each side of which the subjects experience different distinct sensations every time the excitation is extended toward their respective persons. The subjects experience two sensations instead of one (although but one point of each sensorial area be touched with the Weber compasses) every time the excitations are carried into a region situated a little above the anterior median zone. There appears to be a preliminary fusion of the sensations perceived provided quite a strong pressure (at least 30 grms.) be exerted and the two points of the compasses be not more than 15 mm. apart. If a pressure be exerted all around in the hollow of the cartilaginous arch, the subjects will each experience

FIG. 1.—THE XIPHOPAGIS: LIAO-TOUN-CHEN ON THE RIGHT; LIAO-SIENNE-CHEN ON THE LEFT. THE CONNECTING BAND IS SEEN IN THE CENTER.

FIG. 2.—THE SAME UNDER EXPERIMENT, SHOWING THE PNEUMOGRAPHS FOR MEASURING THEIR RESPIRATORY MOVEMENTS.

but chiefly from a surgical standpoint. Our own researches, owing to a most fortunate combination of circumstances, were made under conditions that were almost identical with those of the laboratory. We took with us a complete collection of apparatus and studied the biological and psycho-physiological phenomena collectively. M. H. Tchienne, the interpreter of the Chinese embassy, was extremely useful to us and we have to thank him for the courteous manner in which he aided our researches, of which, in a few words, the following are the principal results:

The two subjects have an independent biological life. The heart, respiration, stature, anthropometrical measurements, muscular strength, etc., are different in the two individuals. The same is the case with the mental life. The table below gives the figures of our results.

The subjects are considered from the standpoint of their respective positions. Liao-Toun-Chen at the right and Liao-Sienne-Chen at the left:

	No. of pulsations.	Blood pressure.	Respiration.	Pulmonary capacity.	Muscular strength.		Stature.
					Back	Abdomen	
Liao-Toun-Chen. ..	90	14.5 mm	22	1.76 lit.	24.5 kg.	18.9 kg.	1.365 m*
Liao-Sienne Chen....	82	15 mm	17	1.27 lit.	17.5 kg.	21.5 kg.	1.350 m†

Liao-Toun-Chen, the subject on the right, is taller than his twin brother and more vigorous. His heart beats more rapidly and his respiratory capacity is sensibly greater than in the subject on the left. The latter, Liao-Sienne-Chen, is left-handed. His free hand is stronger than the one at the side of the point of union, although, from the standpoint of motive ability, he is,

* Anthropometrical dimensions superior to those of the left figure.
† Inferior to those of the right figure.

the same sensations, although the tactile excitation be made only in one of the sensorial areas.

As regards emotions, the subjects undergo these independently. Liao-Sienne-Chen is more emotional than his brother. If an emotion is prolonged, as for example the fear of being pinched—a disagreeable remembrance that they still have as a result of the experiments on their tactile sensitiveness—we shall find notable modifications in the graphic and circulatory curves, although the subject in question undergoes no emotion. The modifications are often subconscient, the subject on the left undergoing them more easily and rapidly than Liao-Toun-Chen. The two subjects possess, in addition, the faculty of accommodating the system of their respiration with a notable spontaneity. The respiratory effort of one is reflected upon the respiration of the other sensibly enough to be detected. The attention of the subjects is variable. In Liao-Toun-Chen the times of reaction, either auditory or tactile, are more rapid; and their sensorial reaction gains when the excitations take place individually for each subject. Liao-Toun-Chen is more attentive and more wide-awake than his brother, and easily adapts himself to intellectual labor.

Such are the principal results of the researches of myself and collaborators. Let me add that the subjects are capable of going to sleep and awakening individually, and that the majority of their psychic acts is dictated by an admirably and previously regulated psychological automatism. Their internal sensations are sufficiently coördinated to allow them to dispense with verbal communications.

Although connected and destined to live inseparably, intellectual harmony in the two subjects that compose this biological couple, which surgeons think of separating, is not perfect. They sometimes have violent disputes. Is this because of the infantile imprint of their character, or because of their difference in humor and manner of being? Experimental researches lead to the conclusion, necessarily, that the latter is the more plausible hypothesis.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

PEARY'S WORK IN 1901-1902.

AFTER four years of brilliant explorations in the far North, Peary has returned to the United States and his last Arctic campaign is ended. A summary of his work during the first three years of this last expedition appeared in the October, 1899, and October, 1901, numbers of this magazine. His work during the past year is summarized in the following modest report to Mr. H. L. Bridgman, secretary of the Peary Arctic Club:

OFFICIAL REPORT BY ROBERT E. PEARY, DATED SYDNEY, SEPTEMBER 7, 1902.

Left at Erik Harbor, on the Ellesmere coast, August 29; the party reached Payer Harbor September 16; crossing Rosse Bay partly by sledge and partly by boat, then walked across Bedford Pim Island.

About a week later my Eskimo began to fall sick, not one escaping. By November 19, six adults and one child were dead; nearly all the others very weak, but out of danger. Early in January Eskimo came across from Anoritok, bringing news of the ravages of a fatal epidemic through the tribe. Word was sent back by these scouts for as many of the survivors as could to come to me, and by the end of the month they began arriving.

In February a large depot of dogfood was established near Cape Louis Napoleon, some 60 miles north of Sabine.

March 3 my advance party of six sledges, in charge of Henson, left for Conger.

March 6 I started with the main party of 18 sledges, leaving Percy in charge at Payer Harbor.

Conger was reached in 12 marches, arriving within an hour or two of the advance party.

My supporting party of Eskimo returning from Conger brought down the instruments, chronometers, and Arctic library.

Eight marches more took us to Cape Hekla. The north end of Robinson Channel was all open water to the Greenland coast, and lakes of water extended northward as far as could be seen from Black Cape and Cape Rawson.

From Hekla another supporting party returned.

April 1 I started northward over the polar sea with Henson, four Eskimo, and six sledges.

Old floes covered deep with snow and intersected with rubble ridges and lanes of young ice were encountered from the moment we left the ice foot. The same kind of traveling (except the lanes of young ice) was found by the English expedition of 1876.

After six marches open leads and floes in motion were encountered. Two natives were sent back.

As we advanced the floes became smaller, the pressure ridges on a grander scale, and the open leads more frequent. Each day's march was very tortuous and our general course deflected west by the character of the ice.

Finally at 84° 17′ north latitude, northwest of Hekla, the polar pack became impracticable and further efforts to advance were given up. New leads and pressure ridges, with foggy weather, made our return in some respects more trying than the advance. Hekla was regained April 29 and Conger May 3. Leaving Conger May 6, Cape Sabine on the 17th, a few days later, I went north as far as Cape Louis Napoleon to complete the survey of Dobbin Bay, returning the first of June.

A proposed trip westward across Ellesmereland was prevented by open water in Buchanan Bay. The ice broke up earlier than in 1901, and Payer Harbor was blockaded almost continuously.

The "Windward" bored her way through the ice and entered the harbor on the morning of August 5, and got out the same afternoon, with scarcely 15 minutes to spare before the harbor was closed by the ice. Forcing our way across Smith Sound, my Eskimo with their belongings were landed in Inglefield Gulf, and several days devoted to hunting walrus for their winter subsistence; then the "Windward" started south, reaching and leaving Cape York the afternoon of August 28.

Calling at Godhaven, Greenland, and Cape Haven, Baffinland, the "Windward" arrived at Choteau Bay, Labrador, September 14 and sent dispatches.

The summer voyage has been without mishap, and the "Windward," with her new engines, has made as good time as the larger and more powerful ships that have been going north the past ten years.

The year at Payer Harbor was passed comfortably, though the anxious strain caused by the ravages of disease among my faithful people was not light. Food was abundant, and our supply of musk ox and deer meat continuous throughout the year.

The northern sledge trip in the spring was arduous, but not marked by special exposure, suffering, or danger more than is necessarily incident to serious Arctic work.

The equipment and personnel were satisfactory, and further advance was vetoed by insuperable natural conditions.

The "Windward" has on board the instruments, chronometers, and Arctic library abandoned by the Greely expedition at Conger, numerous specimens in natural history, bear, musk ox, reindeer, and walrus skins, skeleton of a two-horned narwhal, a rare Arctic specimen; also living specimens of musk ox, walrus, Arctic hare, and Eskimo dogs.

Anchor and chain lost by "Erik" last summer are on board.

The "Fram" left Godhaven about August 20, bound home. She has been in Jones Sound, from whence it is understood explorations were made to the northwest. One death, a fireman, is reported since 1899. Others on board said to be well.

The little schooner "Forgetmenot," caught in the ice at Cape Haven last year, is now on her way to St. Johns.

(Signed) PEARY.

SUMMARY OF PEARY'S WORK.

Mr. Peary has devoted practically the whole of the last twelve years to Arctic work. He announces that he has now retired from Arctic exploration and will hereafter devote his energies to his profession, civil engineering. The results of his long labors in the far North are most important. He has proved Greenland an island and mapped its northern coast line; he has defined and mapped the islands to the north of Green-

land, known as the Greenland Archipelago; he has shown that an ice-covered Arctic ocean probably extends from the Greenland Archipelago to the North Pole; he has accurately defined the lands opposite the northwestern coast of Greenland, Grant Land, Grinnell Land, and Ellesmereland; he has reached the most northerly known land in the world; he has gain d the most northerly point yet reached on the Western Hemisphere, 84° 17'; he has studied the Eskimo as only one can who has lived with them for years; he has added much to our knowledge of Arctic fauna and flora; of the musk ox, the Arctic hare, and the deer; the notes he has made during the past years will benefit meteorology and geology—all these are some of Lieutenant Peary's achievements during the twelve years he has so valiantly battled in the far North. But above all, Mr. Peary has given the world a notable example of a brave and modest man who, in spite of broken limbs and most terrible physical suffering and financial discouragements, has unflinchingly forced to a successful end that which he had decided to accomplish.

To Mrs. Peary, the able seconder of her husband's plans, and to Mr. H. L. Bridgman, the efficient secretary of the Peary Arctic Club, and the loyal members of that club, much credit is due.—The National Geographic Magazine.

THE ELECTRICAL CONDUCTIVITY OF PLANT JUICES.*

By FRED. D. HEALD.

WITH the recent rapid development of physical chemistry, the physiologist has recognized the fact that the application of the methods of physical chemistry to problems of plant physiology is highly important. Already fruitful results have been obtained in a number of lines, and it only remains for future investigations to increase and supplement them. Since "the conductivity of electrolytic solutions stands in direct relationship with certain phenomena," particularly with the osmotic pressure and with the depression of the freezing-point, it has seemed possible that the determination of the electrical conductivity of plant juices, which are themselves electrolytes, might yield interesting results. Some determinations of this character have been carried out, and although the results are not all that might be expected, they are, to say the least, promising, and will be recorded in the following pages.

The conductivity of electrolytes has been an especially prominent subject in the investigations of physical chemistry, so much so that it may almost be called the *Leitmotiv*. The methods of these investigations and the principles established have recently found application outside the province of physical chemistry. A number of instances may be mentioned. The Division of Soils, U. S. Department of Agriculture, has used the electrical conductivity methods for determining the moisture content† of arable soils, and also for determining the temperature‡ and the soluble salt content§ of soils. Oker-Blom‖ has determined the conductivity of blood, serum, and defibrinated blood for cattle and hogs, but rather from the standpoint of the physical chemist than from that of the physiologist. Recently the rate of flow of underground water¶ has been determined by conductivity experiments.

APPARATUS.

Since the apparatus used is probably not familiar to the majority of botanists it will be described more in detail than would otherwise be justifiable. The general plan of the apparatus is represented in Fig. 1. It consists essentially of a Wheatstone bridge in which the galvanometer is replaced by a telephone, *T*. The resistance is measured along the wire, *adb*, which is one meter long, and stretched along a board provided with a millimeter scale. The resistance-box, *R*, contains resistances of 1, 10, 100, 1,000, etc., ohms, and is used for putting into circuit a resistance nearly equal to that of the electrolytic cell *s*. In order to secure a uniform temperature for all measurements, the electrolytic cell, *s*, is placed in a thermostat. The windmill thermostat, such as is used in the laboratory of physical chemistry at Leipzig, is the most practical. According to Kohlrausch polarization effects can be avoided by using an alternating current of high frequency, and consequently a small induction coil, *I*, of very rapid vibration is added, which serves to transform the current derived from the batteries, *B*.

Since the resistance of solutions varies within wide limits, it was necessary to try a number of different kinds of cells before one was found that was adapted to the work in hand. The first form of cell tried is shown in Fig. 2a. It has a diameter of 2 cm., and the platinum electrodes, *e*, are fused into the ends of glass tubes, which are filled with mercury, and securely set in the hard rubber stopper so as to keep the electrodes in a fixed position. The electrodes are covered with a layer of platinum-black by electrolyzing a dilute solution of platinic chloride between them, the object being to increase the surface of the electrodes and thus minimize the polarization effects. This type of cell was found objectionable for two reasons: first, on account of the amount of juice necessary to cover the electrodes; second, because of the small resistance offered, thus making a very indistinct minimum with the telephone. The second form of cell is shown in Fig. 2b. The diameter of the cell was 8 mm., and consequently the resistance of a small amount of solution could be measured, but the minimum obtained with the telephone was indistinct. The form of cell which proved most satisfactory is shown in Fig. 2c. In this U-cell the minimum obtained with the telephone was distinct, the amount of resistance inserted in the resistance-box varying from 500 to 2,000 ohms. The diameter of the tube was 6 mm., and 3 c.c. of solution was amply sufficient to cover the electrodes.

In order to extract a small amount of juice from the roots, stems, or leaves of plants a special form of press was necessary. This press and the method of obtaining the extract have been previously described.*

METHOD.

The capacity of the electrolytic cell must first be determined. This is done by introducing in the cell a solution of known specific conductivity. For this purpose a 1-50 normal solution of potassium chloride was used, and the thermostat was kept at a temperature of 25 deg. C. This was the temperature at which all subsequent measurements were made, the uniform temperature being necessary, since the conductivity of electrolytes varies with the temperature. After closing the circuit and starting the coil, the movable contact (Fig. 1, d) is pushed along the graduated resistance, *ab*, until the minimum for the telephone is found. The resistances are then in the following ratio:

$$R : bd :: s : ad$$

For the resistance,

$$s = \frac{R \cdot ad}{bd}$$

and for the conductivity,

$$\frac{1}{s} = \frac{bd}{R \cdot ad}$$

The solution used was one of known specific conductivity *l*, so we have the following relation:

$$l = k \times \frac{bd}{ad \cdot R} \quad \text{or} \quad k = l \times \frac{ad \cdot R}{bd}$$

1 = 0.002765†, and from the readings made the value of *k*, or the constant for the cell, can be determined. If now the solution of potassium chloride be replaced by the juice which has an unknown conductivity, and the minimum again found for the telephone, we have the new value from which the specific conductivity can be determined:

$$\text{Specific conductivity} = k \times \frac{bd}{R \cdot ad}$$

MEASUREMENTS.

With the apparatus and according to the method just described measurements were made to determine the conductivity of the juice obtained from different parts of plants. The following list represents those

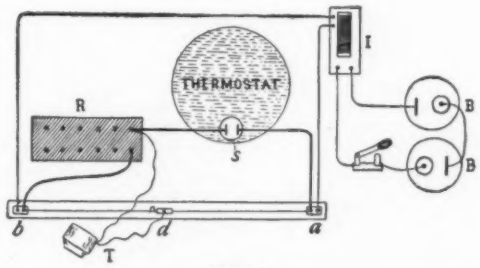


FIG. 1.

species used: *Beta vulgaris*, *Solanum tuberosum*, *Allium cepa*, *Raphanus sativus*, *Nuphar advena*, *Cucumis sativus*, *Amarantus retroflexus*, *Portulaca oleracea*.

I. BETA VULGARIS.

A number of preliminary measurements were made with the juice extracted from the blades of the leaves, the petioles, and the roots, with the following result as an example:

	Specific cond. of juice.
Blades of leaves	0.03652
Petioles	0.03652
Root	0.01891

It will be noted from these results that the specific conductivity for blades of leaves and petioles is the same, hence in the subsequent measurements leaf-blades and petioles are taken together. In order to determine if there was any relation between the conductivity and the amount of ash present in the juice, the crude ash present in 5 c.c. of the juice was found. The crude ash was afterward dissolved in distilled water, diluted up to the original volume of the juice and the specific conductivity of this solution determined. The result is shown by the following:

	Sp. cond. of juice.	Crude ash from 5cc.	Sp. cond. of ash sol.
Leaves	0.02676	0.1651	0.0296
Root	0.01349	0.0626	0.01105

The conductivity of the juice from the leaves is shown to be double that obtained from the root, and the amount of crude ash is in accord with this fact, although the juice from the leaves has a little more than twice as much crude ash as is found in the juice from the roots. Since perfectly pure water may be considered as practically a non-conductor, it is evident that the conductivity of the juice obtained is due to the substances that were dissolved in the cell sap. From the results obtained for the specific conductivity of the solution containing the ash, it will be seen that the conductivity is due in large measure to the dissolved salts, and that the organic products have played only a slight part if any.

It may be noted here that these facts are in accord with the general statements in regard to the ash content of plants:‡ "that the proportion of ash increases from the root upward to the leaves." The different varieties of *Beta vulgaris* analyzed by Wolff§ showed that the leaves contained a much larger amount of crude ash than the roots. It would seem then that the conductivity measurements are here a rough estimate of the relative amounts of ash present in roots and leaves. It must not be forgotten, however, that the juice obtained would not contain all the ash, since some constituents of the ash exist in the plant in the form of insoluble compounds.*

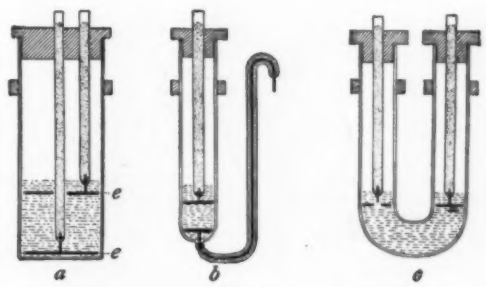


FIG. 2.

2. SOLANUM TUBEROSUM.

Young vigorous plants grown on a heavy black loam were used and measurements made for the juice extracted from the leaves, the aerial stems, and the tubers. The results obtained were as follows:

	Sp. cond. of juice.	Crude ash from 5 c.c.	Sp. cond. of ash sol.
Leaves	0.01959	0.0906	0.01857
Aerial stems	0.02449	0.0781	0.02031
Tuber	0.01505	0.0623	0.01516

The specific conductivity for the aerial stems is higher than that for either leaves or tubers, while the amount of crude ash follows the general law already stated that the amount of ash increases from the roots upward to the leaves. Repeated determinations of the conductivity of the juice taken from different specimens showed similar results, hence it is evident that the conditions here are different from what was found for *Beta vulgaris*. Considering only the tubers and the leaves, the results again show the conductivity to be a rough estimate of the relative amount of ash; but for the aerial stems the conductivity is higher than it should be if ash alone is concerned. How then is the greater conductivity of the juice from the aerial stems to be explained? It is quite probable that it is due in part at least to the greater amount of organic acids present. Titrations of the juice are extremely difficult on account of the color, even when the juice is considerably diluted, but the titrations made indicated more acid than in either leaves or tubers which are rather alkaline. This conclusion is also substantiated by the specific conductivity of the ash solution, which is considerably less than obtained for the original juice. The relative amount of ash obtained by Wolff† for leaves and tubers was slightly different from the above table. His analysis shows that the leaves contain nearly three times as much crude ash as the tubers, but a considerable difference was shown by plants taken at different periods in their growth. The different proportions obtained may then be due to the different times and conditions of growth.

3. ALLIUM CEPA.

The juice obtained from both leaves and bulbs was measured with the following results:

	Sp. cond. of juice.	Crude ash from 5 c.c.	Sp. cond. of ash sol.
Leaves	0.0125	0.047	0.00921
Bulb	0.00525	0.0229	0.00446

The specific conductivity of the juice from the leaves is shown to be more than twice that of the juice from the bulb, and the amount of crude ash obtained from 5 c.c. of the juice follows about the same proportion. The figures for the specific conductivity of the solution made up from the crude ash indicate that the ash alone was not the cause of the conductivity of the juice, but that the organic compounds were concerned. Other determinations were made for this species, and all yielded practically the same results. It may also be noticed that the specific conductivity of the juice from the stalk or stem of a specimen in flower is but slightly in excess of that obtained from the bulb. The relative alkalinity of the ash solution of leaves and bulb is as 2.5 : 1, which is in agreement with the specific conductivity of the solution. The determinations of the specific conductivity of the juice are thus shown in this species to be a rough measure of the relative amounts of ash present.

4. RAPHANUS SATIVUS.

For the common garden radish only specific conductivity determinations were made, using the juice obtained from leaves and root. The results obtained from two different specimens will show how nearly the specific conductivities correspond.

	1. Specific cond. of juice.	2. Specific cond. of juice.
Leaves	0.02105	0.02055
Root	0.02011	0.01833

The difference here between leaves and roots is less than that obtained for any previous measurements, but the conductivity of the leaf juice is still in excess of that obtained for the root. No ash determinations were made for this species.

5. NUPHAR ADVENA.

All of the species used up to this point were taken from places where they had been subjected to about the same conditions of soil and moisture. It was desirable to make determinations for plants subjected

* Botanical Gazette.
† Bulletin No. 6; also No. 12.
‡ Bulletin No. 7.
§ Bulletin No. 8.
‖ Pflüger's Archives 79: 111-145.
¶ Science 14: 972. 1901.

* Jour. Appl. Micr. and Lab. Methods 5:1679. March, 1902.
† LeBlanc, Electrochemie (2te Auflage), p. 77, gives the specific conductivity of $\frac{1}{10}$ normal KCl at 25 deg. C. as 0.002765.
‡ Vines, Physiology of Plants, p. 130. 1886.
§ Wolff, Aschenanalysen, pp. 76-77.

* Vines, Physiology of Plants, p. 131. 1886.
† Wolff, Aschenanalysen, p. 75.

to other conditions and *Nuphar advena* was selected as a good example of a hydrophyte.

Conductivity measurements and ash determinations were made for the juice obtained from the blades of the leaves, the petioles, the rhizome, and the roots. All parts of the plant used were very carefully washed, and all moisture removed from the surface with filter paper before the juice was extracted. The results obtained are shown in the following tabie:

	Sp. cond. of juice.	Crude ash from 5 c.c.	Sp. cond. ash sol.
Blades of leaves...	0.009368	0.0328	0.00784
Petioles	0.009368	0.0327	0.00822
Rhizome	0.00761	0.0298	0.00822
Roots	0.006113	0.0226	0.00568

The above measurements show that there is a progressive increase in the conductivity of the juice from the roots through the rhizome to the leaves, the measurements for petioles and blades of leaves yielding the same results. The crude ash determinations show a like progressive increase from the roots upward. The crude ash was redissolved in distilled water and diluted up to the original volume of the juice, and the specific conductivity of the ash solutions determined. The result obtained for the rhizome ash deviates from what might reasonably be expected, being slightly in excess of that obtained for the juice. The others show a slightly lower conductivity than the original juice, showing that part of the conductivity was due to other than ash constituents.

A comparison may be made of the specific conductivities in this species and some of the previous examples. In *Beta vulgaris* the specific conductivity of the juice from the leaves is three times as great, in *Raphanus sativus* it is over twice as great, and in *Allium cepa* still in excess, although the difference is not great. The results were what might naturally be expected when we consider the aquatic habitat of Nuphar.

6. CUCUMIS SATIVUS.

For the garden cucumber measurements were made for juice extracted from leaves, stem, and fruit. The roots being small it was not possible to obtain the amount of juice necessary to make the measurements. The results are as follows:

	Sp. cond. of juice.	Crude ash from 5 c.c.	Sp. cond. ash sol.
Leaves	0.0127	0.0621	0.01096
Stem	0.0149	0.0509	0.01497
Fruit	0.00632	0.0182	0.00383

This is the only specific in which the juice obtained from the fruit was measured, and the examination of fruits of other species is highly desirable. In this instance it will be seen that the specific conductivity found for the fruit is only about half that found for leaves. Here is also another instance in which the specific conductivity of the juice from the stem is greater than that found for the leaves and is not in accord with the amount of crude ash found.

The specific conductivity of the solutions made from the ash of leaves and stem indicates that little besides the ash constituents were responsible for the conductivity of the juice. For the fruit ash, the specific conductivity is but little over half that of the original juice, which indicates that other substances than the ash constituents were concerned. Litmus tests and titrations indicated that the conductivity was produced partly by the acid content of the juice.

7. PORTULACA AND AMARANTUS.

Conductivity measurements were made for two more species, and the results will be given together. In each case roots, stems, and leaves were used with the following results:

	Portulaca oleracea Sp. cond. of juice.	Amarantus retroflexus. Sp. cond. of juice.
Leaves	0.02445	0.01711
Stems	0.02154	0.01519
Roots	0.01069	0.01328

These figures show that for both species there is a progressive increase in the specinc conductivity from the roots upward. No ash determinations were made for either of these species.

The results obtained and recorded in the foregoing pages indicate that a method may be afforded of determining the relative amounts of ash in different parts of the same plant. Conductivity determinations of the juice from the same species grown on different kinds of soil would probably yield interesting results. It is known that the ash of any given species varies in amount throughout the period of growth, and it ought to be possible to determine the extent of the variations by means of conductivity measurements. If this is possible, then the much more laborious process of an ash determination would not be necessary.

It may be noted in this connection that there is a difference of potential between the shoot and root of a plant, the root being electro-negative and the shoot in a state of positive electrification. Whether the greater conductivity of the cell sap in the shoot is in any way connected with this condition remains an open question. The facts at least are suggestive.

CONCLUSIONS.

A number of conclusions can be drawn from the foregoing records of conductivity determinations. Although others are indicated, a greater number of species must be examined before any more definite relations can be established. From the data at hand the following facts seem established:

1. Plant juices are good conductors, and the conductivity is due in large measure to the dissolved mineral substances, while the organic compounds play a minor part.

2. The specific conductivity of the juice obtained from the roots of plants is always considerably less than that of the juice obtained from subaerial parts.

3. The specific conductivity generally increases progressively from the root upward, although in some cases the sap from the stem has a higher conductivity than that from the leaves.

4. In the majority of cases the specific conductivity is a rough measure of the relative amounts of ash present in different parts of the plant.

Parsons College, Fairfield, Iowa.

THE LIGHTEST OF ALL WOODS.

DEEP in the bogs and swamps of southeastern Missouri, in Dunklin and Butler counties, where the land is never dry and water from one to six feet deep stands perpetually in the forests, there grows a rare and curious tree. The natives know it as the corkwood, or cork, tree. Science has given it a longer name, the *Leitneria floridana*, *floridana* because it was first discovered in Florida along the coast, from which it has long since been washed away. Some meager specimens of it, two to six feet high, are still found in the swamp near Apalachicola, Fla., and a few near Varner, Ark., but in both these places it is exceedingly limited in numbers, an occasional specimen being found, and hardly rises to the dignity of a tree. Only in southeast Missouri, where it reaches a height of fifteen to twenty feet and a diameter of two to five inches, is it really a tree.

What makes the corkwood so remarkable is its exceeding lightness. Beyond a doubt it is, as Mr. William Trelease of the Missouri Botanical Garden has shown, the lightest tree in weight that grows. Its wood weighs less than cork. It is so light that the natives use it to make floats for their fishing nets. And yet its wood, though so spongy that one may easily sink one's finger nail in it, is far tougher than cork. The specific gravity of corkwood, as learned from careful tests made by Prof. Nipher in St. Louis, is .207. The roots are even lighter than the stem; a test showed them to have the astonishingly low specific gravity of .151.

A further idea of the lightness of the corkwood may be gained by a comparison with other woods. The great majority of woods range between .400 and .800. Cork itself is .240. The tree that approaches closest to the corkwood in lightness is the golden fir tree, which grows in the swamps around Tampa Bay and along the Indian River, Florida. Its specific gravity, according to Sargent, is .2616. In comparison with the corkwood, which is the lightest wood with its specific gravity of .207, may be placed the heaviest wood known, the black ironwood of Florida, whose specific gravity is 1.302.

COLD STORAGE FOR APPLES.

THE New Hampshire Experiment Station has a bulletin in press that will give results of experiments from putting apples in city cold storage. This will be distributed shortly. As a forerunner to this pamphlet and in order to call attention briefly to some of the more important points of interest, the following brief abstract is here given of some practical experiments conducted by Professor Rane, the horticulturist of the station.

On November 20, 1899, a number of barrels of apples were shipped to one of the Boston cold storage houses. Beginning with February two barrels were taken out each month until July and examined. The fruit did not receive any extra care and was representative of apples as ordinarily purchased at that time of year on the open market. It was found that the apples could not safely be allowed to remain after April 1st, as they decayed rapidly after that date. The prices at time of shipment ranged between $1.25 and $2, and on April 1st they brought $3.50 to $4.25.

On October 27, 1900, a second shipment of apples were sent to the cold storage with the following results. Prices when put in storage, $1.25. On April 23 ten barrels sold for $34. Expense, carting 50 cents, commission 8 per cent, $2.72. Net proceeds, $30.78 or $3.08 per barrel. Freight and cold storage charges must be deducted from this amount. The storage rates were 10 cents per barrel per month, or for the season ending May 1st, 35 to 50 cents, according to the number of barrels. The freight charges can easily be found out according to the location of the individual.

The greatest care in handling and placing the fruit immediately into cold storage pays for the extra trouble. One must understand that cold storage will simply retard and not prevent entirely the spread of decay. If the fruit is in prime keeping condition on entering it is likely to come out in proportionately as good condition.

Where apples were placed in brine and cold air storage the cold air gave the best results.

From an examination of the prices paid in the fall and those paid on April 1st for the past six years, the results show that there has been a sufficient increase to warrant the extra expense of storage in every case and on the average the practice has resulted in good profit.

Upon examination each month it was shown that the greatest amount of decay was found in the bottom of the barrel as taken out or the headed end as packed. A very large proportion of these were also within six inches of the bottom showing that much care is needed in not overcrowding and bruising the fruit when packing, if the fruit is to be stored.

The reasons that cold storage apples do not keep long after taking them out are that the temperature is so much higher and conditions are far more conducive to decay in the spring. Where the fruit was taken out in the winter months and given spring conditions, as placing them in a warm greenhouse, they decayed equally as quickly.

Our recommendation would be to pick the fruit relatively early, a trifle earlier than the common custom. Use only the best grade for storage, and pick, grade and ship the same day if possible. The sooner the fruit is in storage after it is picked and cooled down to an even low temperature, the better it keeps. Do not expect impossibilities of cold storage. It never makes an ill-shaped apple shapely, an unsound fruit sound, a wormy apple perfect, or a pale, sickly, immature fruit bright colored. The apple cannot be expected to increase in size or overcome rough, careless treatment it perchance may have received before going in. With a proper knowledge of the conditions carefully complied with, there seems to be no question but what the practice of placing apples in cold storage can be recommended.

SELECTED FORMULÆ.

Flash Light for Photography.—The agent most frequently used we believe as the source of light in rapid in-door photography is magnesium. This meal burns readily, emitting during combustion an intense white light. The safest way of using it is to blow the powdered metal through the flame of a lamp, and this method, according to eminent authorities, also gives the best results. A lamp has been specially devised for this purpose, a reservoir for the powdered metal being attached with an air bulb by which the powder is expelled when desired.

Aluminium has also been proposed as a material for producing a strong actinic light, but we do not know how it compares with magnesium, and we judge that it burns less readily.

Flash powders to be ignited by simply applying the flame of a match or laying on an oiled paper and igniting that, may be made by the following formulas:

I.

Magnesium	6 parts
Potassium chlorate	12 parts

II.

Aluminium	4 parts
Potassium chlorate	10 parts
Sugar	1 part

The ingredients in each case are to be powdered separately and then lightly mixed with a wooden spatula, as the compound may be ignited by friction and burn with explosive violence.

It is best to make only such quantity as may be needed for use at the time, which is 10 or 15 grains.

Another way and a much safer one of illumination for photography is by burning a strip of magnesium ribbon. This as found in market is apt to be too thick to ignite readily; but this difficulty is easily overcome by hammering out the end of it quite thin. A length or five or six inches or less so prepared is held in a pincers or other suitable support over a plate or pan so that if it fall no damage will be done, and the flame of a match applied at the thin end will at once start combustion. The time of exposure will soon be learned by experiment.—Drug. Circ. and Chem. Gaz.

Insecticide for House Plants.—

Soft soap	4 drs.
Quassia	72 grs.
Salicylic acid	30 grs.
Alcohol	5 ozs.
Water, sufficient to make.....	24 ozs.

Mix and macerate several days, then filter and add the water. Apply with a brush or plant sprinkler.—Drug. Cir. and Chem. Gaz.

For Cleaning Marble.—

I.

Sodium carbonate	2 parts
Levigated pumice	1 part
Chalk	1 part

Water enough to form a thin paste.

II.

Oxgall	1 part
Saturated solution of sodium carbonate	4 parts
Oil of turpentine.....	1 part

Pipe clay, enough to form a paste.

III.

Soft soap	4 parts
Whiting	4 parts
Sodium carbonate	1 part

—Drug. Cir. and Chem. Gaz.

Geranium Water —

Oil of rose geranium.....	2 ozs.
Tincture of orris root.....	2 ozs.
Rose water	8 ozs.
Alcohol	4 pints

—Drug. Cir. and Chem. Gaz.

Orange Flower Waters.—

I.

Orange flower essence.....	8 ozs.
Magnesium carbonate	1 oz.
Water	8 pints

Triturate the essence with the magnesium carbonate, add the water and filter.

II.

Oil of neroli.....	90 mins.
Magnesium carbonate	1 dr.
Water	8 pints

Proceed as in I.—Drug. Cir. and Chem. Gaz.

Florida Waters.—

I.

Oil of lavender.....	2 ounces
Oil of lemon.....	1 ounce
Oil of orange.....	1 ounce
Oil of cloves.....	5 drachms
Cologne spirit.....	8 pints

II.

Oil of lavender.....	4 drachms
Oil of bergamot.....	4 drachms
Oil of lemon.....	4 drachms
Oil of neroli.....	2 drachms
Oil of melissa.....	1 drachm
Oil of rose.....	20 drops
Tincture of curcuma.....	2 drachms
Alcohol	2 pints

—Drug. Cir. and Chem. Gaz.

Violet Smelling Salt.—I. Moisten coarsely powdered ammonia carbonate, contained in a suitable bottle, with a mixture of concentrated tincture of orris root, 2½ ounces; aromatic spirit of ammonia, 1 drachm; violet extract, 3 drachms.

II. Moisten the carbonate, and add as much of the following solution as it will absorb: Oil of orris, 5 minims; oil of lavender flowers, 10 minims; violet extract, 30 minims; stronger water of ammonia, 2 fluidounces.—Drug. Cir. and Chem. Gaz.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Foreign Insurance Companies in Cuba.—The Department has received from Minister H. G. Squiers, of Habana, the following extract from a letter by Fernando M. Vidal, formerly General Wood's legal adviser, on the subject of requirements for foreign insurance companies doing business in Cuba:

"Foreign insurance corporations are permitted to transact business in Cuba in accordance with the laws of the place of organization, in so far as their capacity to make contracts is concerned, and in accordance with the provisions of the code of commerce relating to the establishment of their houses, their business transactions, and the jurisdiction of the courts. The preliminary requirements are:

"1. Registration in the commercial registry, which consists in filing in the said office a statement showing (*a*) the corporate name or title; (*b*) the nature of the business proposed to be conducted; (*c*) the date when it proposes to commence operations; (*d*) its domicile—i. e., location of its principal office and branches; (*e*) a certified and duly authenticated copy of the charter or certificate of incorporation and the by-laws, with a certificate of the Cuban consul, if any, or due proof that the corporation is incorporated according to the laws of the place of its establishment; (*f*) the general powers of the agents in charge of the branch office.

"2. A deposit in cash or securities, after approval by the Secretary of Finance, in the treasury of the island, according to the following schedule: Life-insurance companies, $25,000; casualty, $25,000. When this deposit is made and approved, the fact is officially published and the company is duly authorized to do business and thereafter pays no further license fees for that purpose, provided that the capital stock is issued abroad, but is liable to general taxes based upon the amount and nature of the business transacted."

Hints to Exporters to Siam.—Consul Walter Schumann, of Mainz, August 22, 1902, says:

A German trade journal gives some valuable hints to exporters to Siam, and says, among other things, that illustrated and handsomely gotten-up catalogues and price lists have only an ornamental value for the oriental. The latter wishes to convince himself personally of the quality of the goods he buys, and exporters who take this into consideration can expect to do a large and profitable business with Siam, while those who rely on price lists or traveling salesmen with samples can do business only with great difficulty. As regards the packing of goods, the report says that articles must never be put up in paper. Pharmaceutical and chemical products must be packed in glass or tin and then bedded in sawdust. For other goods, wood shavings are preferable, because sawdust is apt to escape through holes of the inclosing material. Special care must be devoted to the packing of breakable articles. Textile goods should always be baled and covered with water-tight material, and the bales be bound by iron bands. Articles which rust easily, such as bicycles, should always be packed in wooden cases, lined with zinc and well soldered.

New Steamship Lines to Mexico.—Progreso-New York Line.—The Mexican government has granted a concession to José Gabriel Escalante, of Progreso, Yucatan, for the establishment of a line of steamers, to be called the "Yucatan Steamship Line," to ply between Progreso and New York, with the privilege of calling at Veracruz, Tampico, Galveston, New Orleans and Mobile. The concessionary is authorized to organize a company and the vessels employed must be owned by the concessionary or the company, or chartered for at least six months at a time. The Mexican mail will be carried free of charge, in compensation for which the vessels will be entered and cleared at any time, day or night, except national holidays. The owners of this line are authorized to have their own coaling depots, either on land or pontoons, in the ports where their vessels touch. It is expressly stipulated that the concessionary or the members of the company shall be considered Mexican, and shall be subject to Mexican laws only. The term of this agreement is for three years.

Line to the United States and Europe.—Another agreement recently entered into by the Mexican government was with the Tabasco-Chiapas Trading and Transportation Company, of Frontera, Tabasco, for the establishment of steam navigation between Mexican Gulf ports and one or more American ports, Europe and South America, and also in the coastwise trade between Mexican ports. Vessels must be owned by the company, or, if chartered, the contract must be for not less than six months. Mexican mail will be carried free of charge, in compensation for which the company will enjoy certain privileges, such as the entering and clearing of their vessels at any time, day or night, except national holidays; reduction of 30 to 35 per cent in tonnage dues, etc.; and in compensation for the usual privileges reserved by the government, the vessels of this company will pay only 50 per cent of the charges of the health officer; the stock of the company will be exempt from all federal taxes except such as are required in the way of revenue stamps, and all vessels belonging to this company under the Mexican flag will enjoy the same privilege as any other Mexican vessels. The company is authorized to employ foreigners as masters and chief engineers on the vessels, whenever it is impossible to fill the posts with Mexicans, provided such officers will pass an examination and be qualified under Mexican law. The company may establish its own coaling depots, on land or on pontoons, and repair shops at such port or ports as may be found necessary and convenient, and make contracts with established steamship lines or new ones to promote direct interoceanic traffic, and with railroads for direct transportation to all parts of the republic.—W. W. Canada, Consul at Veracruz.

Trade Hints from Guatemala.—The present financial condition of Guatemala, due in part to the awful consequences of the recent earthquakes, and also to the low prices for coffee—the principal export—has caused widespread commercial depression. Coffee planters, as well as those producing other articles for export or home consumption, complain of the scarcity of labor. When the coffee berry ripens, it must be picked and prepared within a certain time. At this critical period, planters go out into the highways and byways in search of labor, but with little success. It is not known whether the amount of wage is the fault or whether the system drives labor from the country; but it is undeniable that mozos, who compose the bulk of the working classes in this Republic, are abandoning their homes and going into the adjoining countries of Mexico and Salvador, where wages are paid in silver.

The recent settlement of the English, German, French and Belgian claims has been a serious drain on the national exchequer, necessitating an extra duty of 30 per cent (payable in gold), which has placed the price of imported articles beyond the reach of the many, and thus caused a general stagnation in business. The importers have lessened their orders and have resolved, for the present at least, to curtail their stocks.

Packing.—While the subject of packing of United States goods may appear a trifle threadbare, I must say that our disregard of this matter forms the principal barrier to American trade in foreign countries. I was called recently by one of the largest importing houses in Guatemala to witness the unpacking of goods ordered. Out of an order of 50 cases of whisky, 12 cases, or 144 bottles, were broken; how the other 38 cases arrived intact is a mystery. Another shipment was of machine oil. Many of the cans were broken by coming in contact with each other, two cans being packed in one box, too large to keep them secure. The same complaint is heard from drug houses, produce importers, dry goods dealers, jewelers, etc. They inform me that they desire American goods, but that they run the risk of heavy losses if they order from our country. Merchants have repeatedly informed me that they have instructed the firms from which they buy how to pack. Some resent this as an attempt to interfere in their business while others give no attention to such advice. Stationers here import English ink because it comes securely packed, each bottle being bound in strong ribbed paper and the box itself being ribbed and of a durable quality. Under the most advantageous port conditions, goods landed from ships necessarily undergo rough usage; but in harbors having the lighterage system, employing men interested in quick dispatch instead of in the security of the goods, these must be packed strongly enough to successfully endure this handling. It frequent happens that a heavy sea causes the goods to be forcibly hurled against the sides of the ship before they reach the launch. This same thing is repeated when the launch arrives at the pier, which is usually half a mile from the ship. All ships at the port of San José de Guatemala anchor at about that distance from the pier. From the moment that goods are put aboard in New York they are handled roughly, and our exporters should put them up accordingly.

Credits.—Credits are also a cause of discontent. While I fully appreciate the necessity of close attention in this matter, I believe that where houses are reputable and have a good standing, the credit limit should be increased to a reasonable point. I would, however, discourage the indiscriminate credits advanced by European houses, for even though they have permanent representatives on the ground to guard their accounts, their losses are many. A happy medium would probably prove an advantage to all concerned. The European system of having representatives in the five Republics to guard their accounts and to gain trade, of course, tells in their favor. They keep a line of samples continually on hand, and make occasional trips into the neighboring countries. They usually have storehouses, and can supply demands in a very short time. These are the winning elements of the trade here.

Finish of Goods.—Gloss and varnish attract the attention of the people of these countries more than the grade of goods, particularly when the glossed and varnished article can be bought for a much less price than the superior one. They prefer to have two or three new articles rather than one of much better make. This peculiar disposition of the natives is catered to by the foreign houses, who do not stop to argue, but straightway manufacture the article that will sell. Even among the wealthier class, appearance rather than quality effects the purchase.—James C. McNally, Consul-General at Guatemala City.

Promotion of Export Trade in Mexico.—Consul W. W. Canada transmits from Veracruz, September 6, 1902, a newspaper clipping in regard to the promotion of the export trade, as follows:

The Mexican Commercial Commission will depart during the coming week on its long journey through the Republics of South and Central America. The samples which the commissioners will take with them include:

Sacks, binding twine, cordage, matting, etc., made from henequen fiber; silk, cotton, and linen rebozos from Leon, State of Guanajuato; silk hand-made rebozos, from the town of Santa Maria, State of San Luis Potosi, said to be the finest in the country; hosiery and underwear of cotton flannel from Mexico City, Celeaya, etc.; also sewing thread put up to resemble the product of the Scotch mills; colored cotton braid for shoe tags and similar purposes, manufactured in Mexico City.

The array of cotton goods is really remarkable. All the chief factories at Puebla, Mexico city, Orizaba, etc., contribute, and the samples sent by each are substantially the same, though, in general, each of the factories is also represented by a given specialty. The goods include mantas, bleached and unbleached; drills, damasks (alemaniscos) for tablecloths, etc.; percales and prints in every style, some of the patterns being very tasteful; dress goods, with silk finish; dress goods, with velvet finish; men's suitings, almost undistinguishable from woolen goods; muslins, checks, twills, bombazines, organdies, vichy cloth, cotton flannel; also cotton handkerchiefs, towels, yarns, etc. There are further sent crackers and Italian pastes; cigars and cigarettes; woolen suitings and other woolen goods; silk rebozos, silk thread, etc.; an exquisite variety of drawn work from Aguas Calientes; shoes manufactured in Mexico city, Leon, and Saltillo; charro hats; steel rails from the newly started steel foundry of Monterey; whisky and other spirits; cotton hosiery from Guadalajara, Jalisco; all kinds of soap and perfumes from Guadalajara; and beer from the brewery at Orizaba.

The commissioners undertake their journey in a strictly official capacity. They will carry with them the government's credentials and the government is paying the bulk of the expenses, though the manufacturers concerned are also contributing a small share.

The itinerary of the commissioners will take them first to Washington and New York. At New York, the commissioners will receive their cases of samples, and from that port they will sail for Europe. The first South American country visited will be Brazil, which will be reached in October, one of the healthier months of the year. After the commissioners have left Brazil, they will visit Uruguay, Argentina, Chile, Bolivia, Peru, Ecuador, Colombia, Venezuela, Costa Rica, Nicaragua, Honduras, Salvador, and Guatemala.

They will be absent from eight to ten months. Speaking of the matter yesterday, one of them said:

"Our mission, in a broad sense, is to study the markets of South and Central America, or, more specifically, to seek an outlet for the surplus production of Mexico, particularly her cotton goods, in those markets.

"One of the essential features to be discussed will be means of communication. We know that, at the same prices, some of these cotton goods are equal to any manufactured in England, Germany, United States, or France. Therefore, the question of selling them in the markets of South or Central America, in competition with the goods received from the countries which I have mentioned, resolves itself largely into a problem of carrying facilities. This being so, one of our duties will be not only to investigate the possibility of utilizing existing navigation routes, but to take up with the several governments the project of establishing new, direct and mutually subsidized steamship lines between Mexican and other Latin-American ports.

"In this connection, of course, it is important to ascertain the prospect for return cargoes, or, in other words, to determine not only what articles Mexico can sell to the other Latin-American countries, but also what articles those countries can sell to Mexico."

Price of Beef and Scarcity of Cattle in Belgium.—An article concerning the price of beef and the scarcity of cattle in Belgium recently appeared in the newspaper Le National, of Brussels. As it may be of interest to our exporters of beef and cattle, I quote therefrom:

"According to information received from a high official of the Agricultural Department, the probable increase in price of beef is caused by the poor crop of Indian corn in the United States, advance in price of American cattle, extensive purchase of cattle by England in Holland—in short, by a series of causes the effects of which are felt in all countries. In Germany, the retail price of beef has increased 10 per cent.

"The Department of Agriculture says it is a mistake to believe that if the frontier were free to Dutch cattle, the situation would be improved. The sanitary inspection is not an obstacle and nothing prevents the introduction of fat cattle. If cattle are dear on our market, it is simply because they are also dear in Holland, where they are much in demand by English consumers. In view of the increase in price, a reduction of quarantine is asked for Dutch thin cattle, as it is claimed that quarantine is no longer justified as a sanitary measure, since no epidemic of aphthous stomatitis now exists in Holland. Those who advance such an argument forget that tuberculosis is always prevalent there, and quarantine was established for both diseases. Last year, more than 1,600 animals which arrived at the frontier were sent back to Holland on account of tuberculosis. The entry into Belgium of French cattle will not be authorized, as French cattle suffer from numerous diseases."—George W. Roosevelt, Consul at Brussels.

Demand for Motors in Corfu.—The following has been received from Consul B. H. Warner, of Leipzig, dated September 1, 1902:

The director of the agricultural experimental station in Corfu, Mr. A. E. Mavrojani, has asked that catalogues and price lists of petroleum and steam engines and gas motors of low horse power, suitable for running pumps, be sent him.

Improvement of the Port of Algiers.—Under date of September 13, 1902, Consul Thornwell Haynes, of Rouen, says:

The French Government publishes this morning a decree authorizing the Algerian Chamber of Commerce to borrow a sum of 795,000 francs ($153,435), which will be placed, in virtue of subsidy, at the disposition of the Algerian Government for the execution of works to improve the port of Algiers.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1467. October 13.—Electrology in Germany—Official Action in Support of German Export Trade—New Belgian-German Railway—Russian Sugar Surplus.

No. 1468. October 14.—Commercial Experts at German Consulates—Germany's Food Question and the New Meat Inspection Act—Competition for Military Tractor in Great Britain—Trade Opening in Natal.

No. 1469. October 15.—Cocoa Butter in the Netherlands—Copra Products at Marseilles—Improvements at Ceiba, Honduras—Stamps and Coins for Honduras.

No. 1470. October 16.—Lumber Industry in British Columbia—Norwegian Crops—German Trade Under Commercial Treaties—Vehicles in Chile—Bicycle Trade in the Netherlands—Waterworks for Crajowa, Roumania.

No. 1471. October 17.—French Wheat Harvest—German Law Against Unfair Competition—Musical Copyright Bill in Great Britain—German Trade-marks in Morocco—*Inquiry for American Advertising Novelties.

No. 1472. October 18.—New Life-saving Boat in Norway—New Road in Bahia—*Fraudulent Land Schemes in Cuba—The Soochan Mines and Railroad—Export of Russian Kerosene to the East—Signal for Electric Car Crossings in Leipzig.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

Liquid Almond Cream.—A liquid almond cream may be made by the appended formula. It has been known as milk of almond.

Sweet almonds	5 ounces
White castile soap	2 drachms
White wax	2 drachms
Spermaceti	2 drachms
Oil of bitter almonds	10 minims
Oil of bergamot	20 minims
Alcohol	6 fl. ounces
Water, a sufficient quantity.	

Beat the almonds in a smooth mortar until as much divided as their nature will admit; then gradually add water in very small quantities, continuing the beating until a smooth paste is obtained; add to this gradually one pint of water, stirring well all the time. Strain the resulting emulsion without pressure through a cotton cloth previously well washed to remove all foreign matter. If new, the cloth will contain starch, etc., which must be removed. Add through the strainer enough water to bring the measure of the strained liquid to 1 pint. While this operation is going on, let the soap be shaved into thin ribbons, and melted with enough water to cover it over a very gentle fire or in a water bath. When fluid, add to it the wax and spermaceti in large pieces, so as to allow them to melt slowly, and thereby better effect union with the soap. Stir occasionally. When all is melted, place the soapy mixture in a mortar, run into it slowly the emulsion, blending the two all the while with the pestle. Care must be taken not to add the emulsion faster than it can be readily incorporated with the soap. Lastly add the alcohol in which the perfumes have been previously dissolved, in the same manner, using even greater care.

This preparation is troublesome to make and rather expensive, and it is perhaps no better for the purpose than glycerin. The mistake is often made of applying the latter too freely, its "stickiness" being unpleasant, and it is best to dilute it largely with water. Such a lotion may be made by mixing:

Glycerin	1 part
Rose water	9 parts

Plain water may, of course, be used as the diluent, but a slightly perfumed preparation is generally considered more desirable. The perfume may easily be obtained by dissolving a very small proportion of handkerchief "extract" or some essential oil in the glycerin, and then mixing with plain water.—Drug. Cir. and Chem. Gaz.

Tooth Wash.—If the "wash" is intended simply as an elixir for sweetening the breath, the following preparation, resembling the celebrated eau de botot, will be found very desirable:

Oil of peppermint	30 minims
Oil of spearmint	15 minims
Oil of cloves	5 minims
Oil of red cedar wood	60 minims
Tincture of myrrh	1 ounce
Alcohol	1 pint

Care must be taken not to confound the oil of cedar tops with the oil of cedar wood. The former has an odor like turpentine; the latter has the fragrance of the red cedar wood.

For a cleansing wash, a solution of soap is to be recommended. It may be made after the following formula:

White castile soap	1 ounce
Alcohol	6 ounces
Glycerin	4 ounces
Hot water	6 ounces
Oil of peppermint	15 minims
Oil of wintergreen	20 minims
Oil of cloves	5 minims
Extract of vanilla	½ ounce

Dissolve the soap in the hot water and add the glycerin and extract of vanilla. Dissolve the oils in the alcohol, mix the solutions and after 24 hours filter through paper.

A mixture of caramel and cochineal coloring, N. F., gives an agreeable red color for saponaceous tooth washes. It is not permanent, however.

Variations of this formula follow:

I.

White castile soap	1 ounce
Tincture of asarum	2 drachms
Oil of peppermint	½ drachm
Oil of wintergreen	½ drachm
Oil of cloves	5 drops
Oil of cassia	5 drops
Glycerin	4 ounces
Alcohol	14 ounces
Water	14 ounces

II.

White castile soap	1½ ounces
Oil of orange	10 minims
Oil of cassia	5 minims
Oil of wintergreen	15 minims
Glycerin	3 ounces
Alcohol	8 ounces
Water enough to make 1 quart.	

III.

White castile soap	3 ounces
Glycerin	5 ounces
Water	20 ounces
Alcohol	30 ounces
Oil of peppermint	1 drachm
Oil of wintergreen	1 drachm
Oil of orange peel	1 drachm
Oil of anise	1 drachm
Oil of cassia	1 drachm

Beat up the soap with the glycerin; dissolve the oils in the alcohol and add to the soap and glycerin. Stir well until the soap is completely dissolved.

IV.

White castile soap	1 ounce
Orris root	4 ounces
Rose leaves	4 ounces
Oil of rose	½ drachm
Oil of neroli	½ drachm
Cochineal	½ ounce
Diluted alcohol	2 quarts

—Drug. Cir. and Chem. Gaz.

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TABLE OF CONTENTS.

PAGE

I. CHEMISTRY.—Recent Developments in Coloring Matters.—By Prof. OTTO N. WITT. 22434

II. COMMERCE.—Commerce in the Soudan 22431
Trade Suggestions from United States Consuls. 22443

III. ELECTRICITY.—Electricity in Glass Manufacture.—4 illustrations. 22432
The Berlin Electric Underground and Elevated Railway.—I.—6 illustrations. 22439
The Electrical Conductivity of Plant Juices.—By FRED. D. HEALD.—2 illustrations. 22441
The Ruthenberg Electric Iron Process. 22431

IV. MECHANICAL ENGINEERING.—Core-wire Straightening Machine.—3 illustrations. 22433
Pneumatic Tools—Their Use and Capabilities.—1 illustration. 22439

V. MEDICINE.—The Life of a Xiphopagis or "Siamese Twins."—2 illustrations. 22440

VI. MISCELLANEOUS.—A New Egyptian Railway. 22431
Anthracite's Downs and Ups. 22433
Coal-saving Devices. 22432
Cold Storage for Apples. 22442
Selected Formulæ. 22442
The Lightest of All Woods. 22442
Trade Notes and Recipes. 22444

VII. TRAVEL AND EXPLORATION.—Peary's Work in 1901-1902. 22440

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D.
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... 2441
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... 2440
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